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Vol 11

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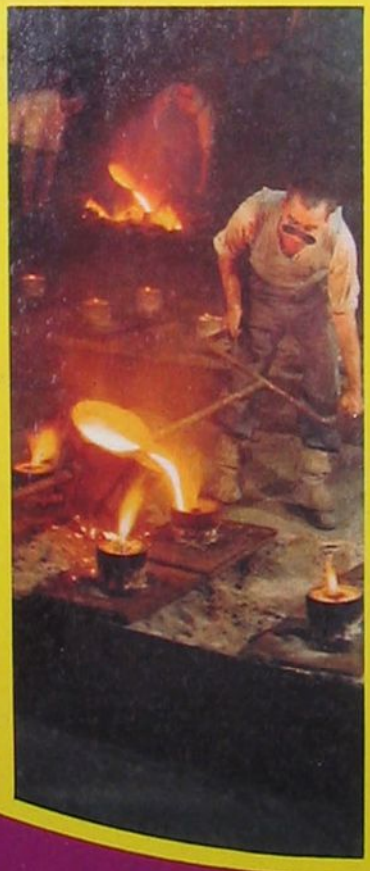

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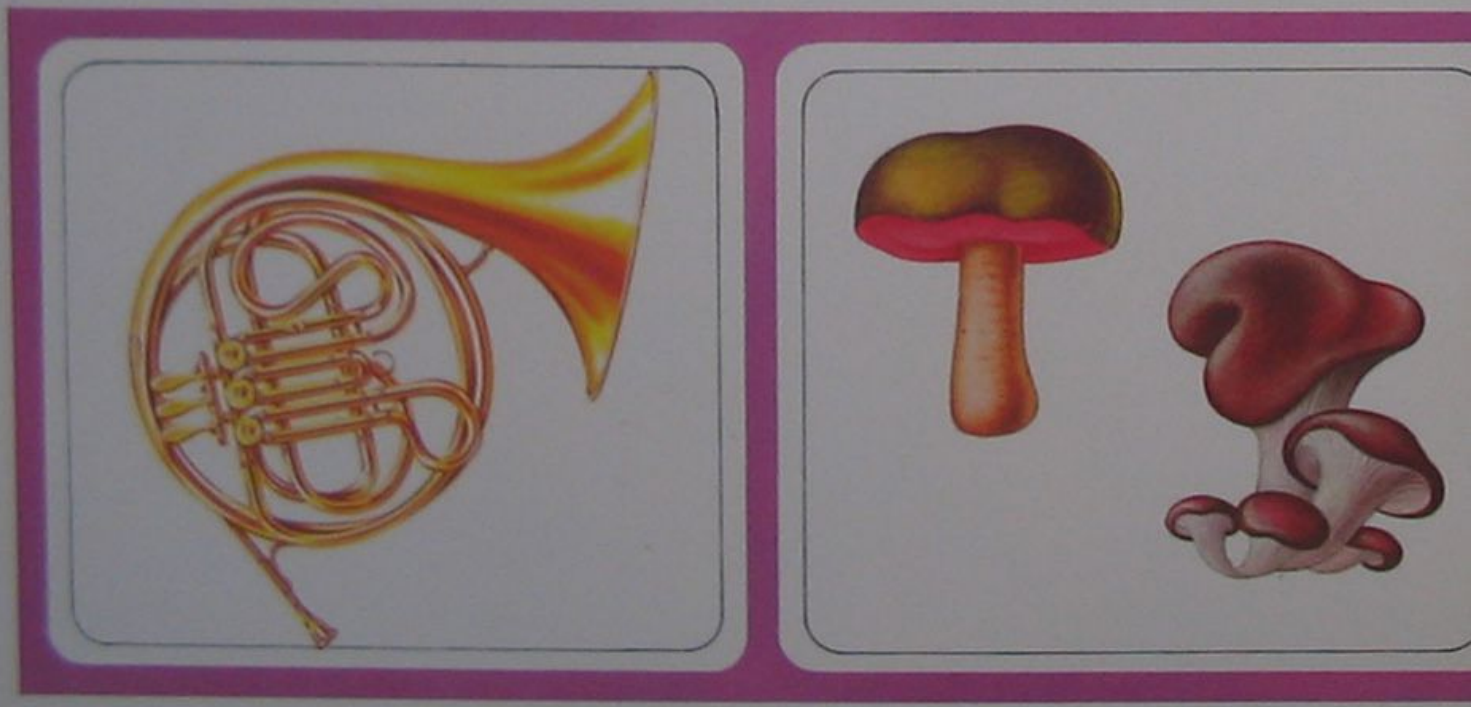

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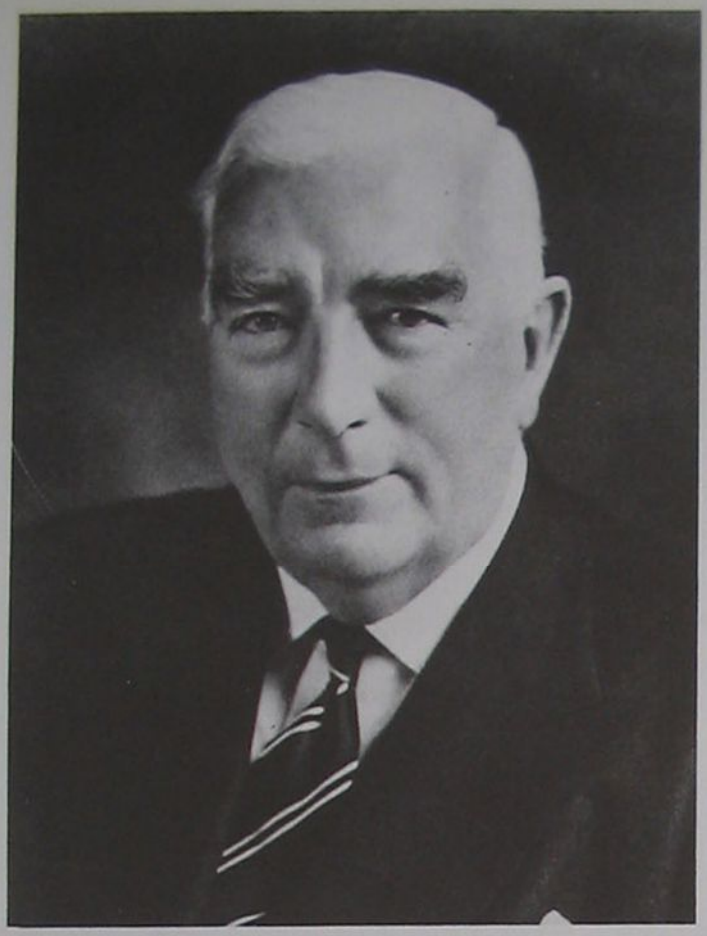
Percussion instruments like the drums played by these Turks are popular in bands all over the world.



Sir Robert Menzies, former Prime Minister of Australia.

Menzies, Sir Robert Gordon (1894-), served as prime minister of Australia for 19 years. He was born in Jeparit, Victoria, and held a law degree from the University of Melbourne. From 1928 to 1934 he served in the Victoria state legislature and later represented this state in the federal House of Representatives.

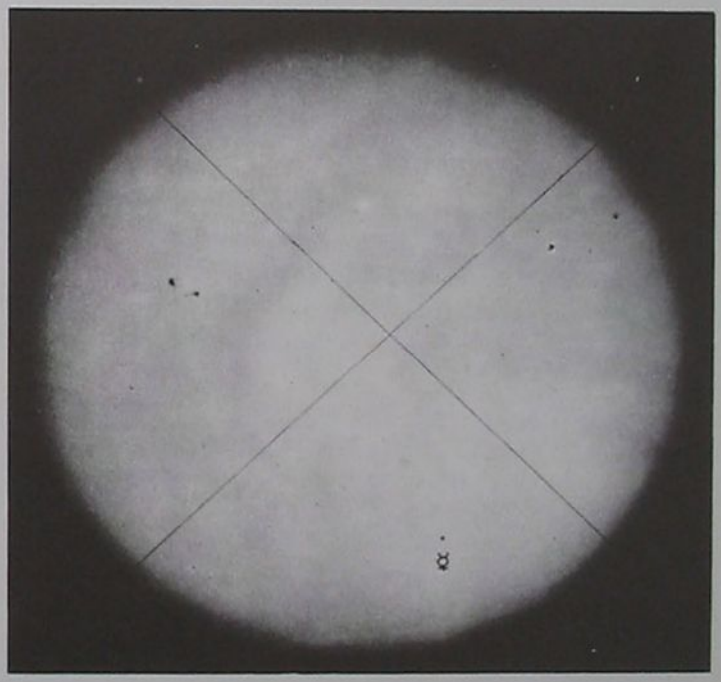
Menzies was Australia's Attorney-General from 1935 to 1939. He became prime minister as leader of the United Australia Party after the death of J. A. Lyons. Menzies advocated sending troops to fight in World War II. Out of office after 1941, he organized the Liberal Party which won a majority in 1949, again making him prime minister. Though very pro-British, he also established ties with the United States. Menzies retired from office in 1966.

Mercury is the only metal that is liquid at ordinary temperatures. Its silvery colour and the way it flows has earned it the name of quicksilver. The most familiar uses of mercury are in thermometers and barometers. In vapour form, it is used in the bluish-white mercury lamps for street lighting.

Most metals dissolve in mercury to form *amalgams*. Dentists use gold and silver amalgams to fill teeth. Chlorides of mercury are used in medicine as antiseptics. But like all compounds of mercury, they are poisonous.

Mercury is the smallest planet in the Solar System, the one closest to the Sun and the one that travels fastest through space—at more than 100,000 miles an hour.

It also has the shortest 'year', taking only 88 Earth days to go round the Sun. There are few surface markings, so that it is difficult to measure the 'day'—the



Mercury is a small planet when compared with the Earth (right). It is not easy to observe owing to the fact that it is usually hidden by the Sun's glare. It sometimes passes between the Sun and the Earth and during these transits it can be seen through a telescope as a small black dot against the Sun (above).

time Mercury takes to spin on its axis. This was for a long time also thought to be 88 days, but recent measurements suggest it may be only 59 days.

Mercury is a very difficult planet to see. It is always close to the Sun and is usually hidden by the Sun's fierce glare. When it can be found, it appears either low in the western sky, just after sunset, or low in the eastern sky, just before sunrise.

Life as we know it would be impossible on this sunbaked planet. During the long day it is so hot that lead would melt. At night it is far colder than anything experienced on Earth.

Merioneth (area 660 square miles), a mountainous county in north-west Wales, claims some of the most beautiful scenery in Britain. Its county town is Dolgellau, and its population is 35,300.

Merioneth borders Cardigan Bay. Among its imposing peaks is Cader Idris (2,927 ft). There are many lakes, the largest being Lake Bala. The principal river is the Dee. Sheep and cattle are raised, and there is some slate and limestone quarrying. Tourism is a flourishing industry. The main towns are Blaennau Ffestiniog, Towyn and Barmouth.

Metals Man has been using metals for at least five or six thousand years. Civilization as we know it today could not exist without them. Iron is by far the most important of the metals because it forms the basis of steel—noted for its great strength. Aluminium and copper follow in importance.

An open-cast copper mine. In this type of mining the ore is taken out by trucks or railway wagons which travel along the terraces.

All of the metals are solid at ordinary temperatures, except mercury, which is liquid. Most of them are silvery in colour, but a few, such as gold and copper, are coloured. They have a typical shiny, metallic appearance. Most metals conduct both heat and electricity well—silver and copper are outstanding.

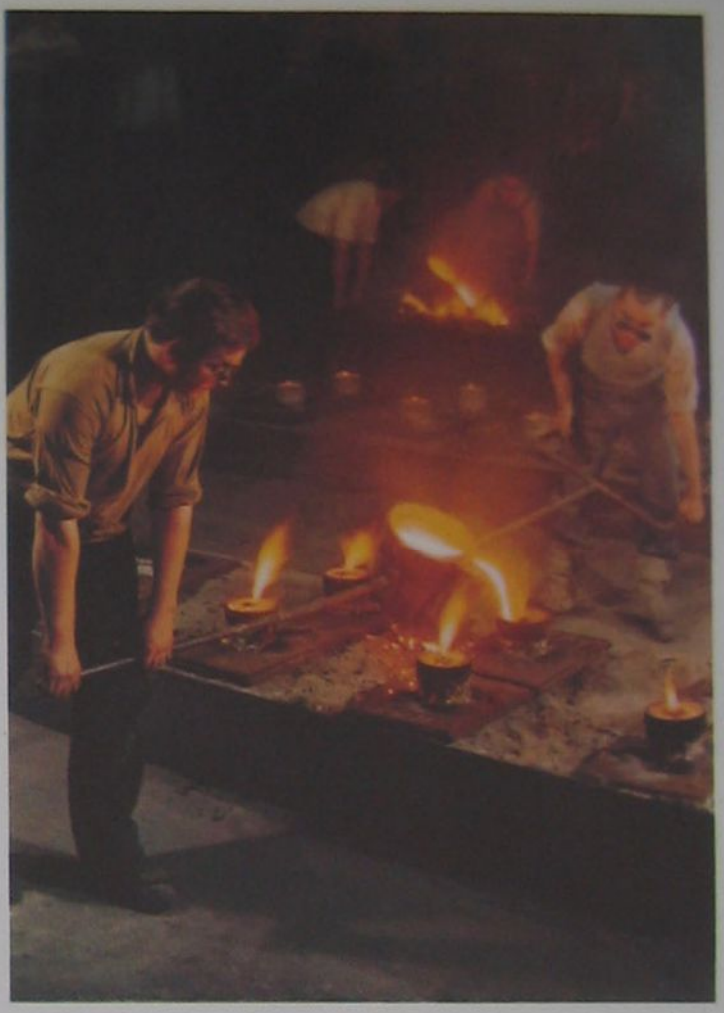
The physical properties of metals vary widely. Many metals are hard and tough, but some are soft and weak. Gold, silver, and copper are *malleable* and *ductile*—they can be hammered into thin sheets and drawn into fine wires. But many other metals are brittle and difficult to shape. Fortunately, we can often improve the properties of a metal by adding another metal or other element to it to form an *alloy*. (See Alloys.)

The metals are chemical elements—the basic materials from which everything in the world is made up. But not many metals occur on Earth *native*, or in their familiar metal form. Most of them are found as minerals, in which they are combined with other chemical elements. When these metallic minerals can be processed to give the pure metal, they are called *ores*.

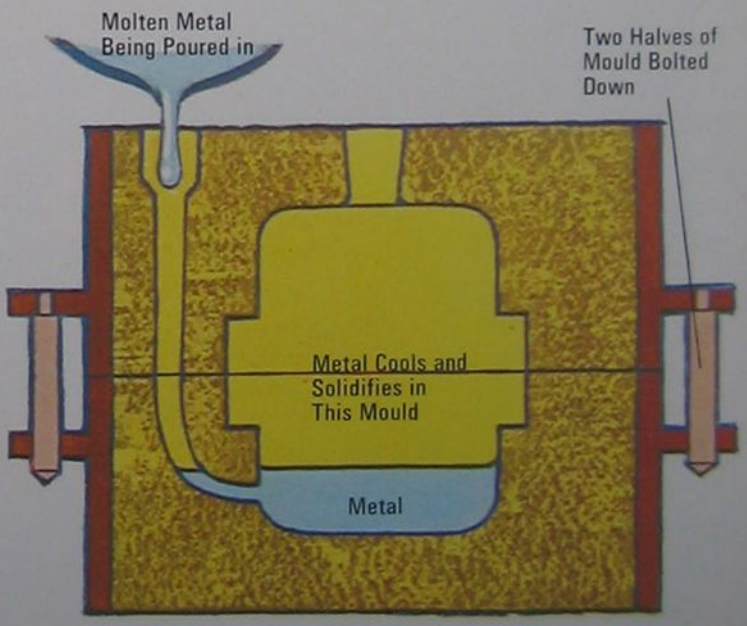
Gold, platinum, silver, and copper can be found native because they do not combine readily with other elements. But practically all the other metals are too reactive to be found native. Many ores are combinations of the metal with oxygen (oxides), sulphur (sulphides), and carbon and oxygen (carbonates).

Native metals and ores are not found in all parts of the world. They occur in certain regions in limited deposits. Taking these deposits from the ground is called mining. If the deposits lie near the surface, mining may involve simply excavating or dredging. But if they lie deep underground, elaborate and expensive machinery has to be used. (See Mining.)

The ore coming from the ground must pass through many stages before pure metal is obtained. Then the metal must



Casting is one of the simplest ways of shaping a metal. A casting is made by pouring molten metal into a mould of the required shape (above). The metal then cools and solidifies in the shape of the mould. Moulds may be made from sand or metal. The diagram below shows a cross-section of a sand-casting mould being filled with molten metal (coloured blue). When the metal has filled the space and cooled, the mould must be broken apart to release the casting. Metal moulds can be used more than once.



Above: Cold-rolling aluminium sheet.

Top right: Hot-rolling a steel girder. The ingot is passed through a series of powerful rollers which squeeze it to the desired size.

Right: Molten steel from a furnace is poured into huge metal moulds where it gradually cools down and solidifies to form *ingots*. The picture shows the moulds being stripped from the red-hot ingots.

be shaped and finished in various ways. The science which deals with extracting, purifying and shaping the metal is called *metallurgy*.

The ore coming from the ground is usually mixed with unwanted earth and rock. This *gangue* may sometimes be removed simply by washing. But usually more complicated methods are needed. A common one is *flotation*. The impure ore is crushed finely and put into a special frothing solution. The pure ore particles float away in the froth while the impurities sink.

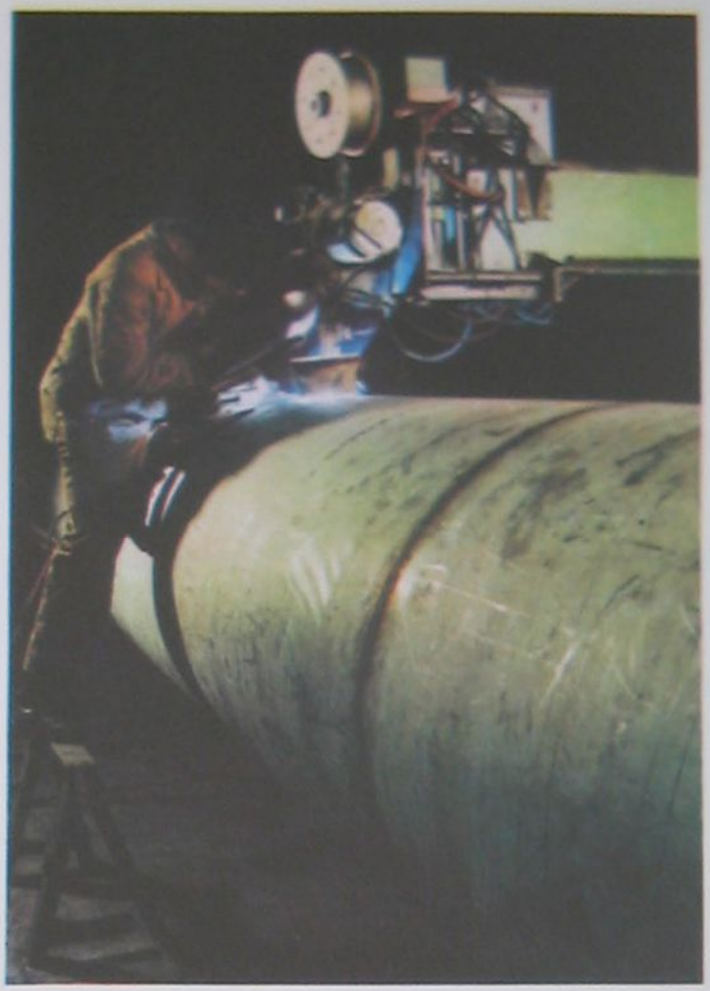
This concentrated ore may then have to be *roasted* in air so that further processing is easier. Or it may need *sintering*—heating to high temperatures—to bind the particles of ore into lumps. After these preparatory stages, the ore is ready for *smelting*—the extraction of the metal.

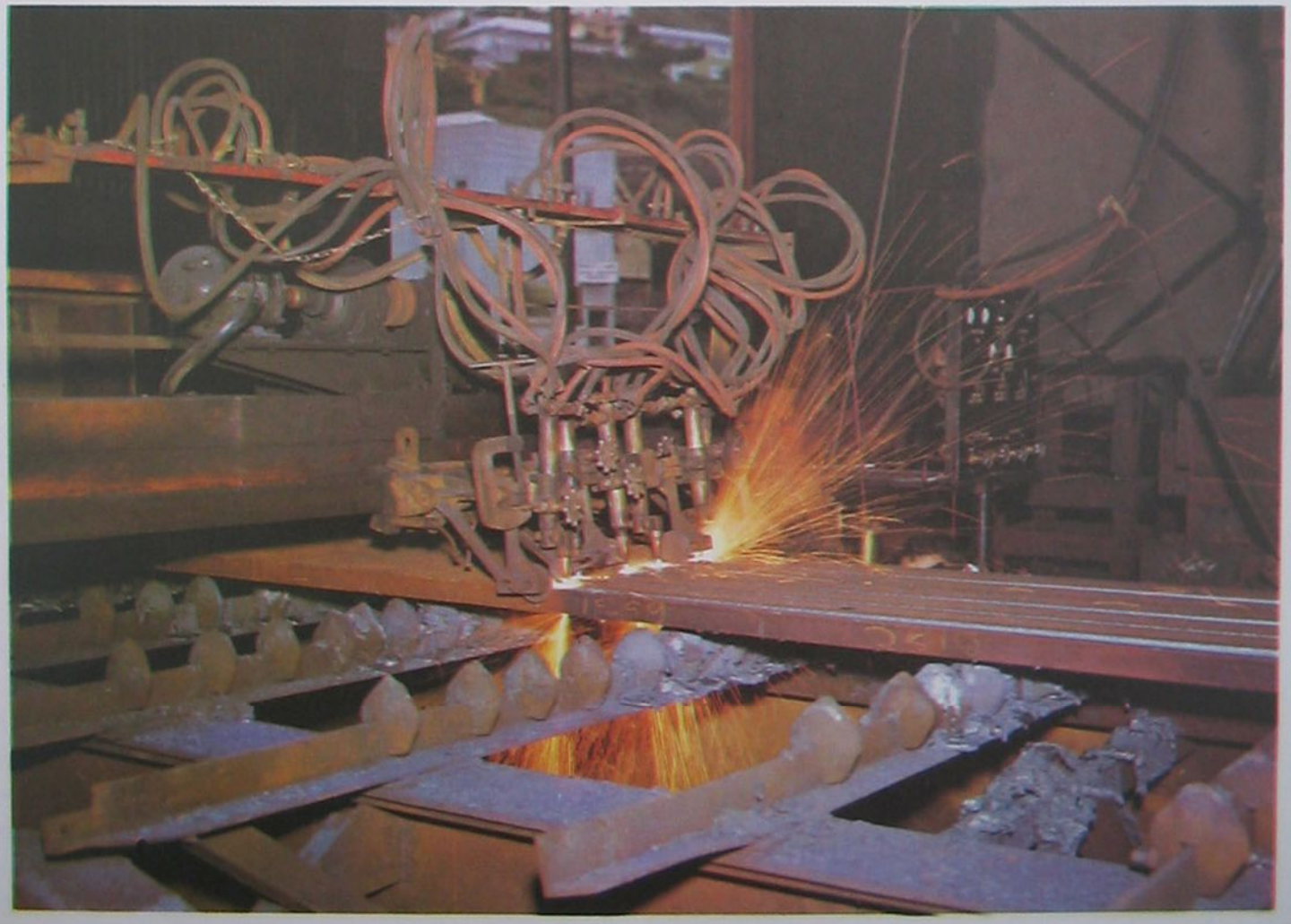
Smelting involves heating the ore with certain substances so that the metal separates out. The impurities form a layer of slag. Several common ores, including iron and lead ores, are smelted with coke and limestone in huge blast furnaces. (See Iron and steel.) Aluminium smelting is rather different. The metal is

Above: Drilling and reaming are two of the most common operations in the machining of metal. Large machines may be fitted with a number of drills or reamers which can be used in quick succession. Reaming involves slightly enlarging a drilled hole to very accurate dimensions.

Right: Welding steel pipe sections. Arc welding is now the most important method of welding. This involves making an electric current arc (jump a gap) between an electrode and the metals to be joined. The temperature of the arc is very high (about 3,660°C) and the metals melt and run together.

Below: Using oxy-propane torches to cut steel girders automatically.





produced by passing electricity through a molten solution of the ore in another mineral. (See Aluminium.)

Some metals, including copper, can be extracted from their ores not by smelting but by *leaching*. In leaching, the metal is dissolved from the ore with chemicals.

Most metals extracted by smelting or leaching still contain impurities and must be further purified, or *refined*, before they can be used. Refining may involve heating the impure metal with substances to remove impurities in a furnace. Or it may involve passing electricity through a solution of the metal. This *electrolytic* refining is used to refine copper, for example. Furnace refining is used for iron and steel.

The purified metal is then ready to be shaped into its final form. Sometimes it is shaped hot, sometimes cold. Molten metal is shaped by *casting*. It is poured into a mould of the desired shape made of sand or metal. The metal mould, called a *die*, can be used over and over again. This method is called *diecasting*.

Hot but solid metal can be shaped in various ways—*forging*, *rolling*, and *extrusion*. Forging presses or hammers the metal into shape. In the drop-forge, a heavy hammer falls onto the metal and forces it into a die. The hydraulic press squeezes heavy pieces of metal into shape.

Thin sheet for automobile bodies or tin cans is made by rolling. The metal is usually rolled cold after hot-rolling to give it a harder and more accurate finish. Tubes and rods are made by extrusion. The hot metal is forced through a hole in a metal die. To make a tube, the metal is squeezed between the die and a steel rod. Wires are made by drawing cold metal through a die. A metal rod is drawn through successively smaller holes until it becomes wire.

Often objects are made by joining together pieces of metal rather than shaping them from a single piece. *Soldering* and *welding* are common methods of joining metals. Some objects are made by moulding them in metal powder and then pressing and heating the moulded powder. This technique is called *powder metallurgy*.

Most metal parts are given their final shape by *machining*, which includes *turning*, *drilling*, *milling* and *grinding*. These operations are carried out by various machine-tools of which the *lathe* is one of the most important. (See Lathe.)

The final metal product may be coated with another metal or merely painted to protect it from corrosion. *Electroplating* and *galvanizing* are two methods of coating metals for protection. (See Electroplating; Galvanizing.)

Talking points

* Iron is one of our most useful metals. It first began to be used about 1100 B.C. in the *Iron Age*. Gold was in use as early as 3500 BC. For what reason do you think that gold came into use so much earlier?
* There are over 70 known pure metals that are found in the Earth's crust. List them and their properties. What uses can they be put to?
* Metal has many uses of great importance in our modernday society. It must be assumed that the supplies of metal in the Earth will eventually run out: for example, there are only enough known reserves of copper to last until the year 2010. Discuss what action should be taken to prevent disaster when this happens.

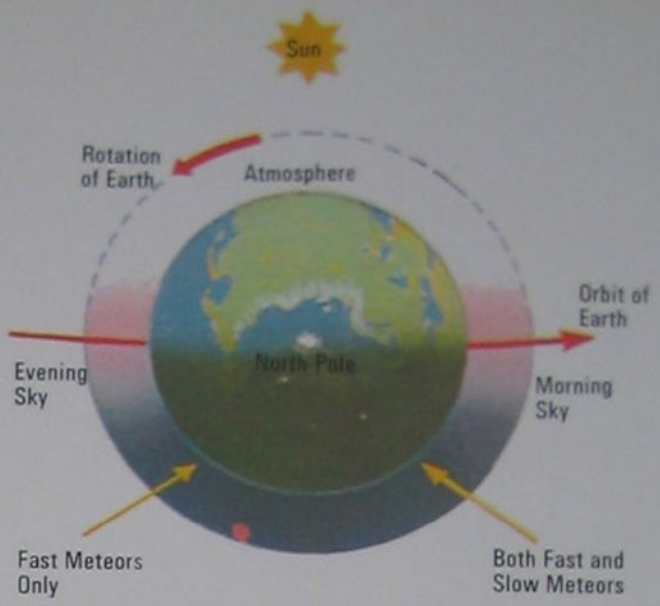
Articles to read

Aluminium; Iron and Steel.

Meteorology is the study of the Earth's atmosphere and weather. Scientists called *meteorologists* measure the atmosphere's pressure, temperature, moisture content, and movement. They collect information on sunshine, rainfall, and clouds, and forecast changes in the weather.

Meteors On its journey round the Sun the Earth collides with millions of small fragments. They are usually made of stone, and range in size from huge boulders weighing several tons to tiny particles of dust. A lot of this *meteoric dust* floats slowly down through the atmosphere and lands on the surface.

The larger fragments plunge through the atmosphere at tremendous speed and meet such air resistance that they become white-hot. This is when we can see them at night as 'shooting stars' or *meteors*. Most of them are burnt up high above the



Meteors are only visible when they enter the Earth's atmosphere. Friction with the air causes them to glow with heat and they become a 'shooting star', a bright line of fire which flashes momentarily across the sky. Meteors can only be seen during the hours of darkness and they are most plentiful in the morning skies. The Earth is itself moving through space and in the evening only fast meteors coming up behind the Earth will enter the atmosphere. Towards morning, however, the same region is on the forward side of the Earth and both fast and slow meteors can enter the atmosphere.

Earth, but some are so big that only part of them is burnt before they land.

Those that reach the surface are called *meteorites*. They range in size from small pebbles to great blocks, many tons in weight. Occasionally an enormous one lands, causing great devastation and making a huge crater. In Arizona, U.S.A., there is a crater 600 feet deep and almost a mile across made by a meteorite which struck the Earth in prehistoric times.

Sometimes the Earth passes through swarms or *showers* of meteors. These are believed to be fragments of comets.

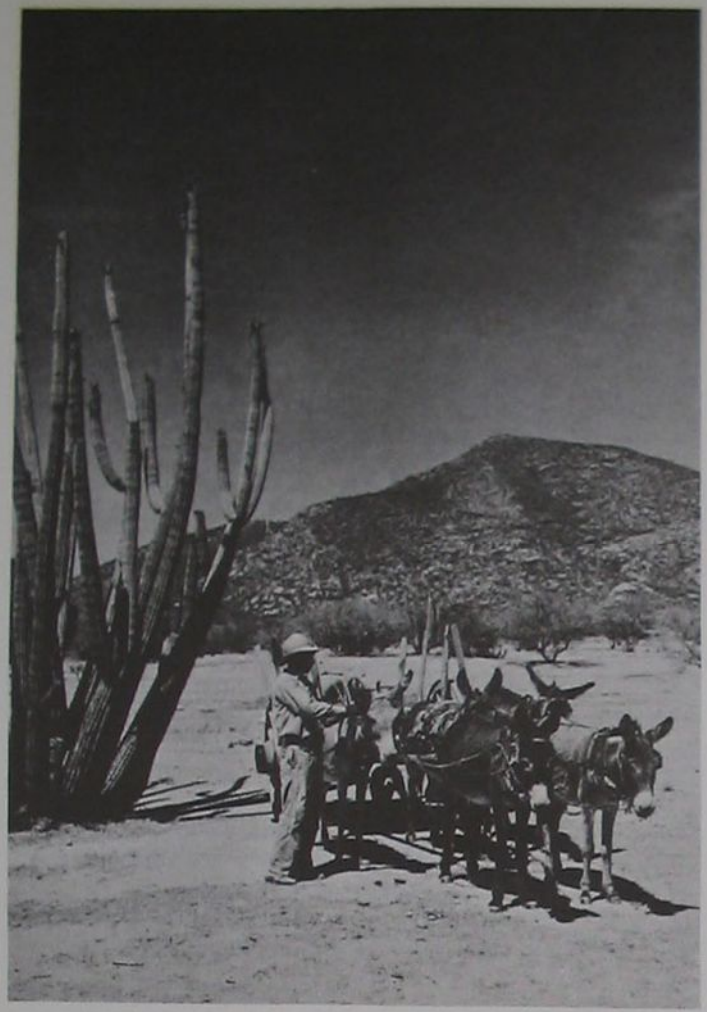
Metric system This is a system of weights and measures used by scientists and in many countries of the world. It is named after its unit of length, the *metre*, which equals a little more than a yard. The unit of mass is the *gramme* (about 1/28 of an ounce) and the unit of volume is the *litre* (just less than a quart).

Smaller and larger units in the metric system are formed by adding prefixes to the basic unit:

prefix	*meaning*
milli	= a thousandth
centi	= a hundredth
deci	= a tenth
deka	= ten times
hecto	= hundred times
kilo	= thousand times

For example, a milligramme is a thousandth of a gramme, a centimetre is a hundredth of a metre, a decilitre is a tenth of a litre. A kilometre is a thousand metres (equals 5/8 of a mile). (See Weights and measures.)

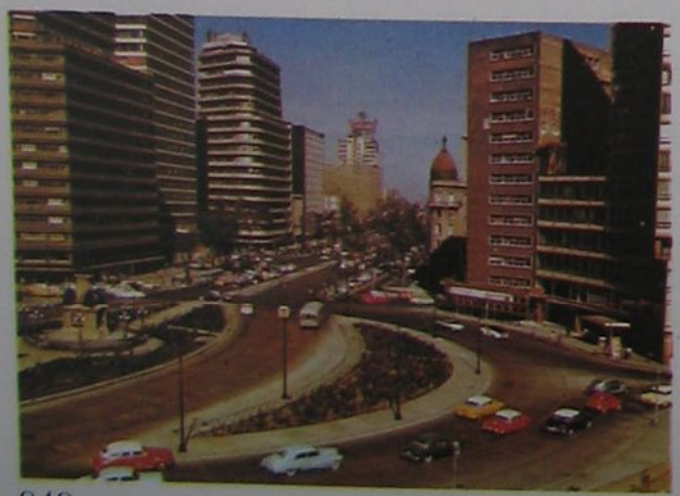
Mexico is a Spanish-speaking country in North America. It lies south of the United States, bordering Guatemala and British Honduras in the south. Mexico was the centre of several great ancient civilizations, including that of the Aztecs. Mexico was conquered by the Spaniards



Above: Deserts cover much of northern Mexico. In these undeveloped areas mule-drawn carts still form an important means of local transportation.

Right: Location map of Mexico.

Below: Mexico City, the capital city, lies on the central plateau, the most densely populated part of the country.



in 1519, but many impressive ruins from the early civilizations still stand.

Geographically, Mexico is a land of great variety. Deserts cover much of the north. They include the 810-mile-long peninsula of Lower California, the Sonora Desert bordering the north-western coast and the northern plateau which is enclosed by the Western and Eastern Sierra Madre, two rugged mountain ranges. These ranges merge into one in southern Mexico. The central plateau which lies near the junction of the two ranges has fertile valleys and large towns and cities. Volcanoes rise from the central plateau. In central Mexico, the mountains extend to the sea, but in the south-west, they border a narrow, isolated coastal strip. The eastern coastal strip is a long, hot and wet area, where malaria is common. Another peninsula, the Yucatán peninsula, lies in the south-east.

The climate of Mexico varies greatly from the northern deserts to the southern hot rainy region. The climate is also greatly affected by the altitude. Mexico City, at 7,500 feet above sea level, is far cooler than coastal regions.

About three-quarters of all Mexicans are *mestizos*, people of mixed European and American Indian origin. The rest are either of Indian or European ancestry. The official language is Spanish, but Indian languages are also spoken.

Most Mexicans work on farms, where important crops for export include coffee and cotton. Other important exports are copper, lead, petroleum and silver, with ebony and mahogany. Manufacturing industries are expanding quickly.

The Aztecs had established their great civilization by the AD 1300's. In 1519, a Spanish adventurer, Hernando Cortés, led a small Spanish force into the heart of the Aztec empire. He first befriended Montezuma, the Aztec emperor, who thought Cortes was a god. But many Aztecs opposed the Spaniards and rebellions broke out. The Spaniards crushed the Aztecs and destroyed much of their civilization.

After a fierce struggle, Mexico regained its independence in 1821. In 1824, the country became a republic. Wars and revolutions ravaged Mexico until the 1900's. From the 1930's, Mexico achieved much more stability and began to make rapid progress. In the 1960's, the Mexicans began a major expansion of schools, and redistributed millions of acres of land to farm workers.

Facts and Figures
Area: 761,602 square miles.
Population: 48,013,000.
Capital: Mexico City.
Money Unit: peso.
Labour force: 56% rural; 44% urban.
Exports: coffee, cotton, lead, silver.
Imports: machinery, motor vehicles, wool.

Mexico, Gulf of, is a large extension of the Atlantic Ocean. It borders on Mexico and the southern United States. Cuba lies at the entrance to the Gulf. The Yucatán Channel and the Straits of Florida join the Gulf with the Atlantic Ocean and the Caribbean Sea. The Mississippi and several other rivers pour their waters into the Gulf.

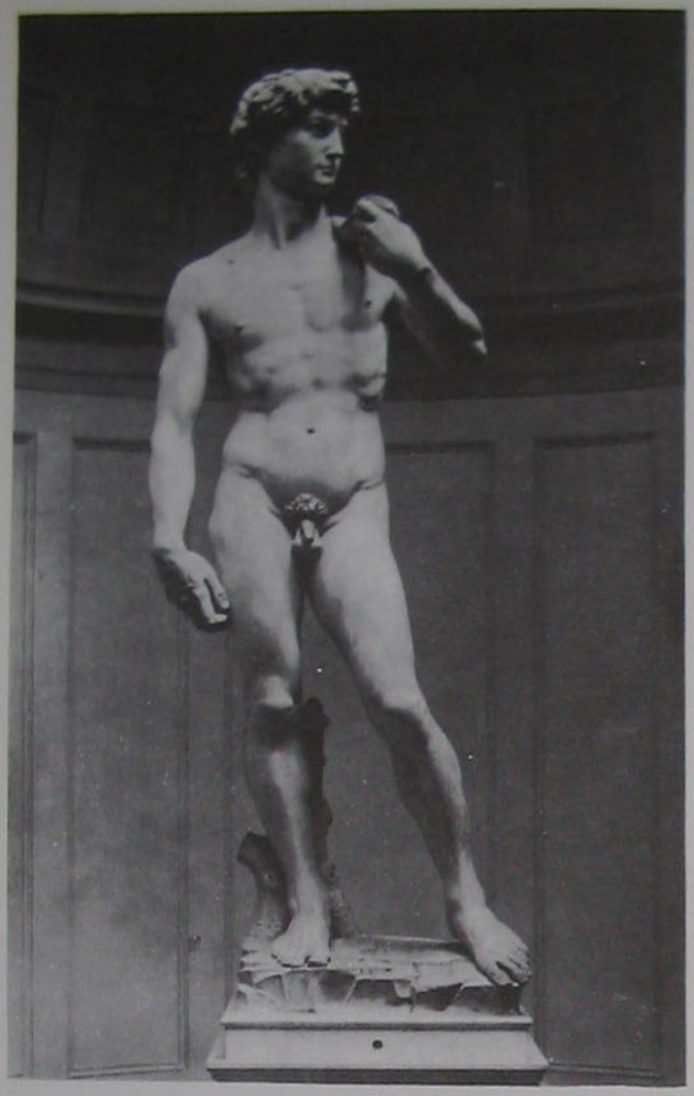
The Gulf of Mexico has an area of about 615,000 square miles. It is about 1,100 miles long and 775 miles wide. The deepest point is over 12,700 feet.

The Gulf provides fishermen with rich catches of shrimp and other sea foods. Offshore drilling brings oil from the continental shelf. Seasonal winds and hurricanes can sometimes hinder commercial activities.

Michelangelo Buonarroti (1475-1564) was born in Florence, the son of a poor gentleman called Ludovico Buonarroti. Early in life, despite his father's opposition, he was determined to become an artist. He was only 13 when he started studying in the workshop of a Florentine artist, and he later went to the school of sculpture set up by Lorenzo de' Medici. Like many talented men of his time he became not only a painter, but a sculptor, architect, and poet.

In 1496 he went to Rome and obtained commissions from rich patrons. One of his great works was a statue of the Madonna holding the body of the dead Jesus. But in 1501, at his father's urgent request, he went home to help his family. It was at this time that he carved his superb statue of David, the Old Testament hero, from a block of marble so big that other artists had been afraid to use it.

Michelangelo (left) was the greatest of all Italian sculptors, and also a painter and architect. He built the great dome of St. Peter's in Rome, and painted the fresco in the Sistine Chapel. Below: One of Michelangelo's unfinished paintings.



Michelangelo's *David* was carved from a block of marble so large that other sculptors were afraid to use it.

Pope Julius II called Michelangelo back to Rome in 1505 to design a great monument, but eventually insisted that he should decorate the great ceiling of the Vatican's Sistine Chapel. This Michelangelo did, though he much preferred sculpture to painting. For a period of four and a half years he lay on his back on scaffolding erected a hundred feet above the floor, and completed a great painting of 10,000 square feet, depicting the Creation of the World according to the Book of Genesis. He was so scrupulous that he would not allow assistants to help with the work.

The rest of his life was spent between Rome and Florence. In Rome he painted the huge picture of *The Last Judgement* above the altar of the Sistine Chapel. Even as a very old man he never ceased creative work, and at 72 was the chief architect of St Peter's in Rome. He died at the age of 89.

Michigan is a prosperous midwestern state in the United States. It borders Canada and four of the five Great Lakes. The state, which covers 58,216 square miles, is divided into two separate peninsulas by Lake Michigan. A five-mile-long bridge connects the two parts.

Michigan has 8,875,000 people. Eight out of every ten live in the southern peninsula where there are industrial cities and fertile farmland. The state capital is Lansing. The chief city, Detroit, is the centre of the giant motor-car industry which employs more than half the manufacturing workers in the state. Michigan produces large quantities of steel, and also mines the iron to feed the mills. Copper mining and smelting, cement-making and food-processing are other important industries.

The tourist trade is second only to the motor-car industry. The state has vast lake-front areas and many lakes and streams. Visitors come to take part in hunting, fishing and other sports, and to visit places of interest. The moderate climate and varying soil types allow farmers to grow alfalfa, maize, oats and many kinds of fruits and vegetables. Cattle, pigs and poultry are also raised.

Michigan was first explored in the 1600's by the French, who established

This location map shows the position of Michigan.

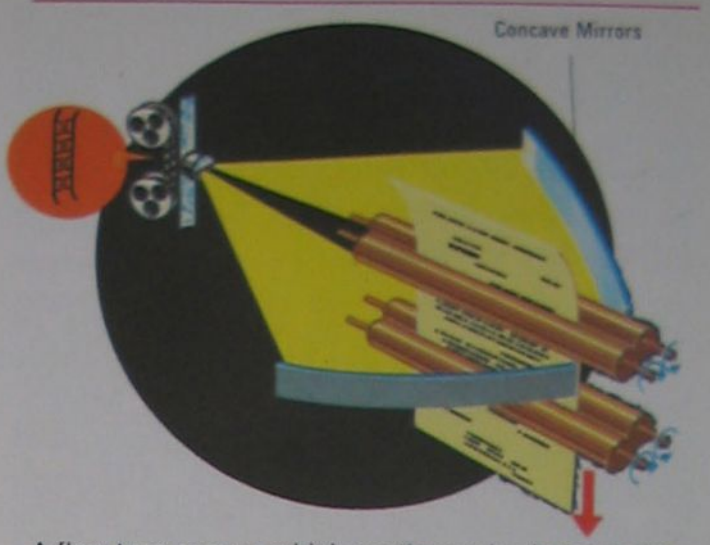
fur trading in the region. France lost Michigan to Britain in 1763. Michigan became the 26th state in 1837.

Microbiology is the study of living things too small to be seen with the naked eye. These include protozoa, bacteria, viruses, yeasts, and certain algae and fungi—all known collectively as micro-organisms. Microbiologists may also study cells from larger plants and animals. They work in many fields of medical and space research, and in industrial laboratories. The basic tool of the science is the *microscope*.

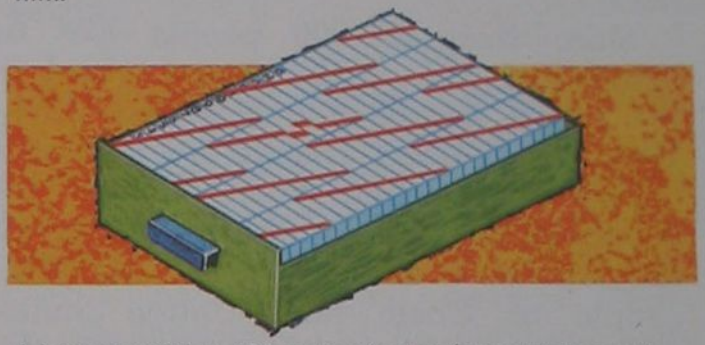
Microbiologists grow *colonies* (large collections of organisms) from minute specimens in sterilized test-tubes and flat glass dishes called *Petri dishes*. The organisms feed on liquids known as *broths* or on a jelly-like substance containing *agar*, which comes from seaweed. Meat extracts and other nutritious substances are added to the agar in varying amounts to make it suitable for a wide variety of micro-organisms. In the right temperature, humidity and light, the organisms will multiply rapidly and the culture can then be subdivided for various experiments and tests. For viewing under the microscope the organisms are placed on a glass *slide* and may be coloured with various *stains* to make them more visible.

The first microbiologist was a Dutchman, Anton von Leeuwenhoek. Using simple microscopes of his own making, he observed and described bacteria and yeasts in the 1680's. During the 19th century many advances were made in microscope design and in the techniques of bacteriology. Louis Pasteur, Robert Koch, Paul Ehrlich and others studied disease germs. Advances in technology and equipment made in the 20th century include the *electron microscope*, capable of magnifying 100,000 times.

Microfilm In research establishments, libraries and offices reference must often be made to past books, papers and plans.



A flow type camera which continuously photographs both sides of a moving document. The images of both sides of the document are recorded side by side on the film.



A box containing 100 reels of microfilm which could contain the subject matter of some 8,000 books. A diagonal stripe is marked on the top of every 10 boxes.

Storing all this material in bulk and sorting through it to find information would be too wasteful of space and time. What is done is to photograph the material on a narrow strip of film, or *microfilm*. This considerably reduces the bulk to be stored and handled. The contents of a whole book can be stored on a strip of film a few feet long. The copy can be read easily when the strip is viewed in a projecting machine or *reader*, which magnifies the image.

The kind of film normally used for microfilming is 35 mm roll film. Sometimes individual frames are inserted in punched cards, which identify them. Information may also be stored on microfiches—'cards' of film about 4 by 6 inches. Each card can contain the pages of a whole book.

The extent to which the printed material is reduced varies—according to the

purpose for which it is required. It is possible to reduce it very much smaller until the image becomes a tiny dot. Spies have used these so-called *microdots* to pass on secret information. They insert a microdot instead of a full stop in a letter, for example.

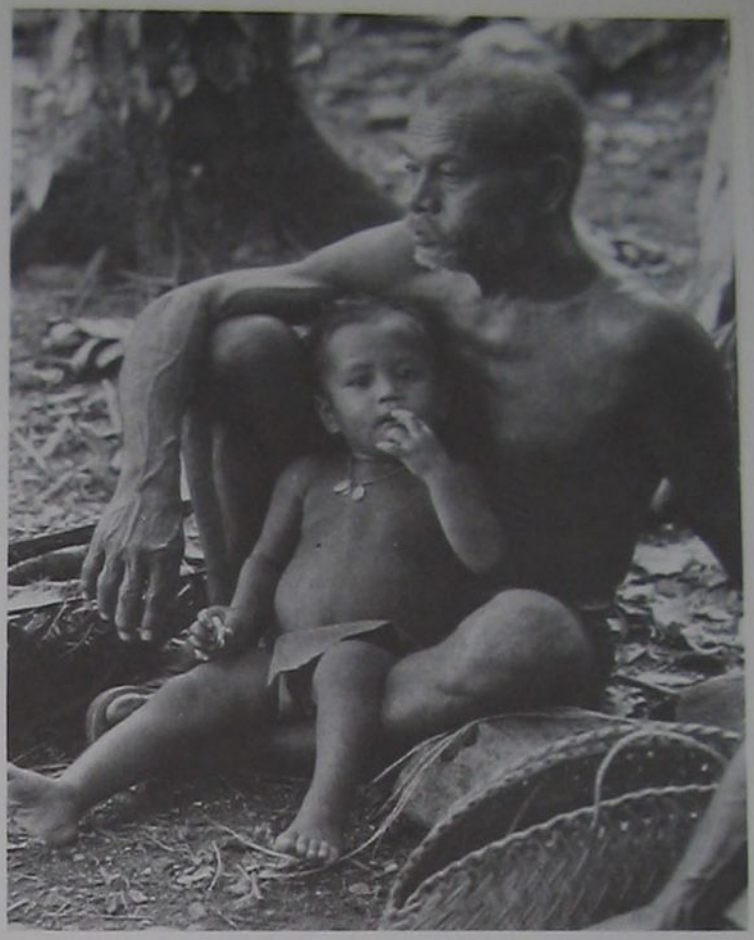
Micronesia is one of three groups of islands in the Pacific Ocean, the others being *Melanesia* and *Polynesia*. Micronesia lies east of the Philippines and generally north of the Equator. Although the combined area of the islands is only 1,100 square miles, they are scattered over many thousands of square miles of ocean.

More than 263,000 people live in Micronesia. Nauru, the largest island in the group, has been independent since 1968. The Gilbert Islands are a British colony; Guam and Wake Islands are American possessions, the former being the site of a large military base. The people of Guam hold United States citizenship. The other islands—the Marianas, Carolines and Marshall Islands—are administered by the United States as the Trust Territory of the Pacific Islands. The United States has used the Marshall Islands for atomic testing.

Most of the islands are low coral formations, but some are volcanic and mountainous. Temperatures are usually hot; typhoons bring high winds and heavy rainfall.

Native Micronesians are generally short to medium in height, with brown skins and dark, sometimes curly, hair. They speak languages of the Malayo-Polynesian group. Most are westernized in their dress and nearly all of them are Christians.

Micronesian villages, formed of related families, are built by the sea because fishing provides most of the people's food. Micronesians fish in shallow lagoons and in deep-sea waters. They build outrigger canoes of lashed wood, with triangular mat sails. Yams, taro, breadfruit, coconuts, pandanus fruits and sweet potatoes make up the rest of their diet.

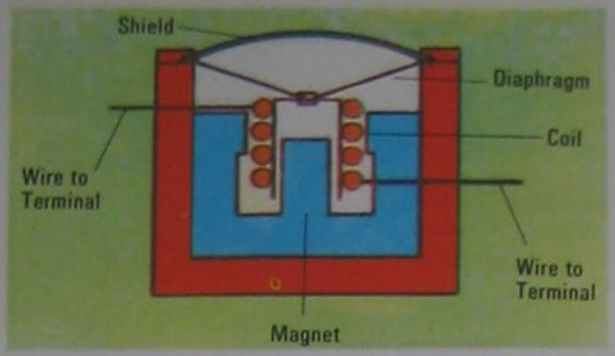


An elderly Micronesian looks after his grandson. Most Micronesians are fishermen.

Micronesia exports little besides *copra* (dried coconut) and phosphates for fertilizer, collected on Nauru. Native handicrafts—woven textiles, baskets, palm leaf mats and carved objects—are sometimes sold.

The Portuguese explorer, Ferdinand Magellan, reached the Marianas in 1521. Spain gradually acquired much of the region, but lost it in 1898, after the Spanish-American War. The U.S. thus acquired Guam, and the Germans took possession of the other islands, in addition to Nauru which they already held. Britain acquired the Gilberts in 1892.

Japan took many of the islands from the Germans during World War I and others from the United States during World War II. After Japan's defeat by the Allies, the Trust Territory was established.



Above: A diagram of a magnetic *(moving coil)* microphone. The vibrations of the diaphragm are converted into a varying electric current.

Below: A hand microphone of this type.

Microphone A microphone converts sound waves into electric voltages or currents that vary in step with the variations in the sound wave. The most common microphone, used in telephone handsets, is the *carbon* type. The heart of this type of microphone is a button-shaped container filled with carbon granules. Sound waves cause a diaphragm attached to this button to vibrate; and this in turn causes the pressure on the granules to vary, which varies their electrical resistance. An electric current flows through the granules and the variations in their electrical resistance causes its strength to vary.

Better quality sound and music reproduction can be achieved by using a *ribbon* microphone, which is widely used in broadcasting. In this type, the sound wave vibrates a thin metal ribbon suspended between the poles of a permanent magnet. As it vibrates, the ribbon cuts the magnetic field and a varying electric current is induced in it. (See Electricity.)

Condenser microphones are often used for very high quality recordings and for experimental work involving sound measurements. Here, the vibrations of the diaphragm cause the electrical capacitance of the microphone to vary. The diaphragm forms one plate of an electrical capacitor (see Electronics): the other plate is fixed to the back of the microphone. External circuits connected to the microphone convert the capacitance variations into voltage variations.

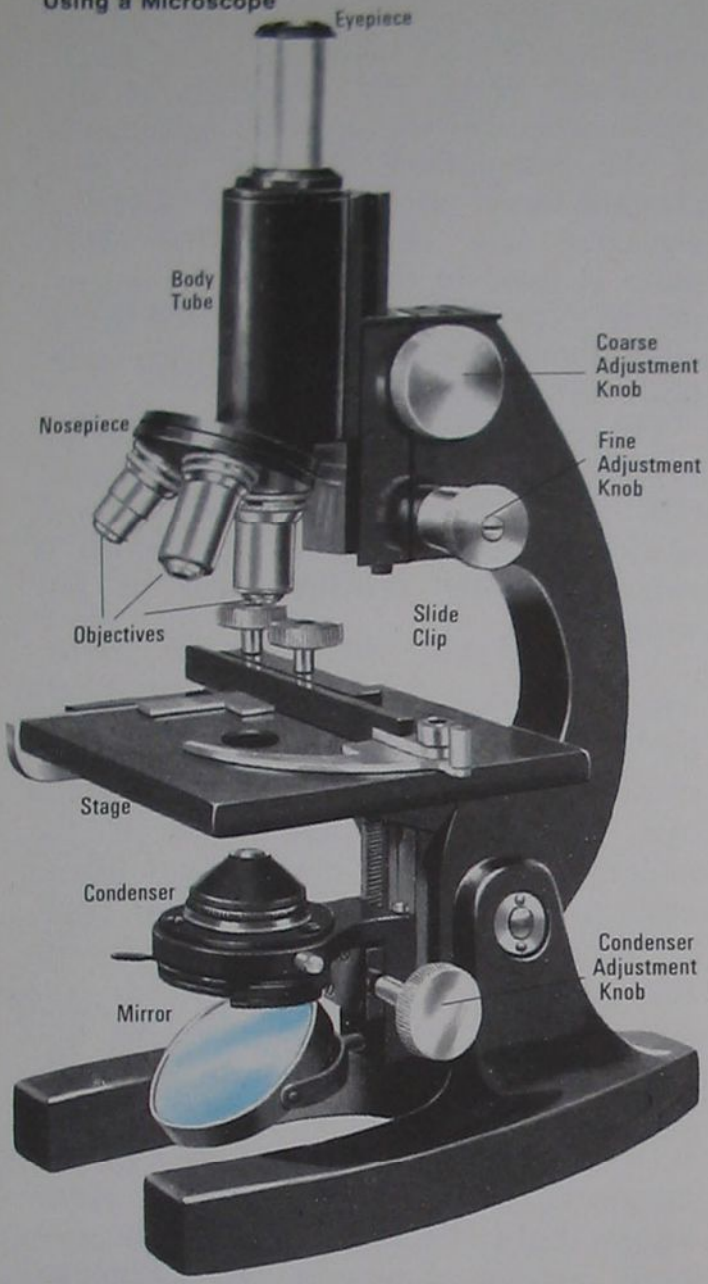
Other types of microphones include the *crystal* type, which is cheap; the *dynamic* type, which is useful for public address work; and the *magnetic* type which is rugged, highly sensitive and of low weight.

Microscope A microscope is an instrument for magnifying objects whose structures cannot normally be seen with the naked eye. The simplest microscope is the *magnifying glass*—a convex lens placed close to the object being examined. Higher magnifications can be obtained with the *compound microscope,* which consists basically of two lenses. One lens (the *objective*) is placed close to the object. The image formed by the objective is then examined by another lens (the *eyepiece*). In modern compound microscopes both the objective and the eyepiece consist of several lenses mounted together. The objective and eyepiece are fixed in the ends of a metal tube which serves to exclude light which does not come directly from the object.

The object itself must be brightly lit. If the object being examined is a thin, slightly transparent section, it is lit from below. If the object is thick and opaque, it is lit from above. In both cases a third lens (the *condenser*) is used to concentrate light onto the object from an electric lamp.

The magnification of a microscope is the number of times the diameter of the object is enlarged. A magnification of × 100, for example, means the diameter is

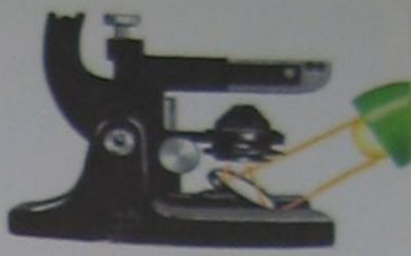
Using a Microscope



The parts of a standard optical microscope. The framework of this type of microscope consists primarily of the *foot* or base, the *tube*, which contains the lenses, and the *body*, or upright support that holds the tube.

Mirror Adjustment

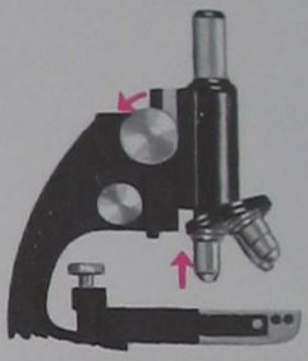
Light shining on the mirror is directed on to the object by adjusting the tilt of the mirror. If daylight is used, it is better to use light from a cloudy part of the sky rather than sunshine direct.



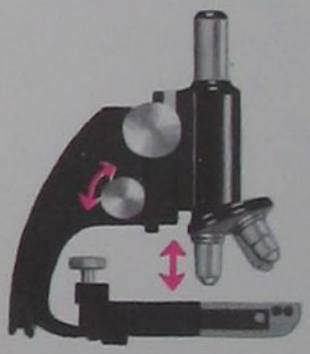
High-power Focusing

Wind the body tube, with the high-power objective lens in position, right down by rotating the coarse adjustment forwards, so that the lens is almost touching the specimen.

Slowly move the coarse adjustment (large knob) backwards, thus raising the high-power objective away from the specimen until it is in rough focus.



When the specimen is in rough focus rotate the fine adjustment (lower knob) until it is clearly in focus. The same procedure is carried out using the medium power objective.



Low-power Focusing

To focus the object under low power, rack the tube down until the objective almost touches the slide, using the coarse adjustment, then rack upwards until the object is in focus.

enlarged a hundred times. The objective produces a magnified image first, then this image is given further magnification by the eyepiece. The total magnification of a compound microscope is the magnifying power of the objective multiplied by the magnifying power of the eyepiece. A × 50 objective and a × 4 eyepiece, for example, would give a total magnification of × 200.

The greatest magnification which a compound microscope can give is about

× 2,000. At magnifications above this the details of the object become too blurred and distorted to be recognizable. In fact a good microscope must not only magnify a small object; it must be able to distinguish between two very tiny particles which are close together. The ability to do this is called the *resolving power* of a microscope.

The molecular and crystalline structure of objects can be examined using a *polarized light microscope*. Polarized light (see Light) is used to illuminate the object, which is then examined through a disc of 'Polaroid' film. The structure of the object can then be seen as a series of 'wavy' bands of light and dark. Polarizing microscopes are used to examine the stresses and strains in models of structures made of industrial materials and the molecular structure of living cells.

Very high magnifications of up to many thousands of times can be achieved using the *electron microscope*. Instead of light, a stream of electrons from an electrically heated filament passes through the object. The electron 'beam' is spread out as it passes between the poles of an electromagnet, and a magnified image is formed as the electrons expose a sheet of photographic film.

Below: The electron microscope is one of man's most valuable research tools. Its magnifying and resolving power can be increased in practice by using a number of electro-magnets.

Middle Ages is the name given to the period in European history between Ancient and Modern, that is, from the end of the Roman Empire until the late fifteenth century. All this period was once called the Dark Ages. Now that name is applied only to the earlier part, up to about the year A.D. 1000.

In the Middle Ages all western Europe was under the influence of the Roman Catholic Church. The style of church buildings was at first Romanesque (or Norman) with round arches, and then Gothic, with pointed arches. The age has left its cathedrals, monasteries and parish churches as reminders of how important religion then was. At times the pope seemed to have more power than the strongest king.

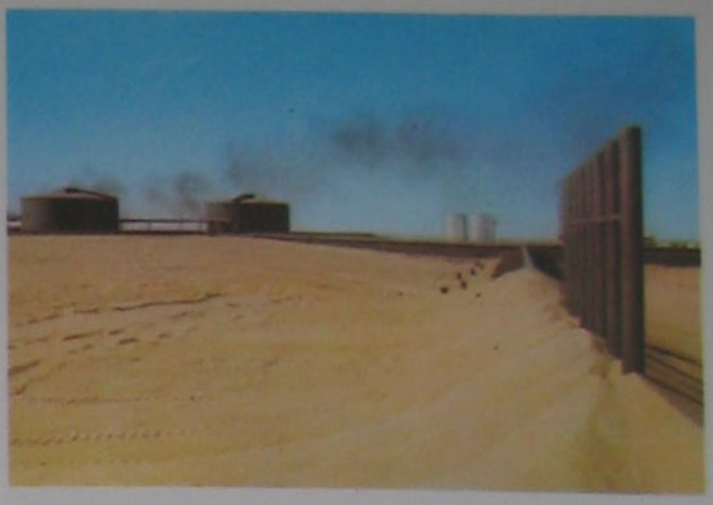
The castles that still dot the map of Europe remind us also that this was an age of feudalism (see Feudal System). By the end of the Middle Ages, barons were losing power to the kings in countries like France and England. Private wars stopped, and manor houses were built as castles fell into ruins.

During the Middle Ages the wastelands of Europe were colonized and turned into ploughland or pasture. Most of this work was done by villeins. These were men who were not slaves but were not free. They belonged to a lord, and paid rent for their land in the form of work.

Towns were very small by our standards, but they became common from the twelfth century on. In them the guilds of merchants and craftsmen began to live less under the control of lords, priests or monks.

Across the middle of this period fell the shadow of famine and plague. By the

Le Krak des Chevaliers, a Crusader castle in the Lebanon, is today still in almost perfect condition. Castles such as this are among the most impressive relics of the Middle Ages.



Storage tanks and flare stacks at an oilfield in Libya. Oil is the Middle East's most valuable export.

thirteenth century the population was increasing faster than the supply of food. The years 1315-17 saw the worst famine ever in Europe. In 1348-9 and again later the Black Death killed immense numbers of people. For a time building in stone stopped; villages shrank or were deserted; and towns dwindled.

With the recovery from famine and plague came change. Scholars began to challenge old beliefs that no one had dared question before. Many new ideas came together in the Renaissance which marked the beginning of Modern History. (See Renaissance.)

Middle East is a name used to describe an area east of the Mediterranean Sea. The term has no precise meaning but is usually meant to include Turkey, Syria, Lebanon, Jordan, Iraq, the whole of Arabia, Israel, Egypt and Cyprus. Sometimes Iran (Persia) and other nearby states are included in the term. Geographers call most of this region south-western Asia.

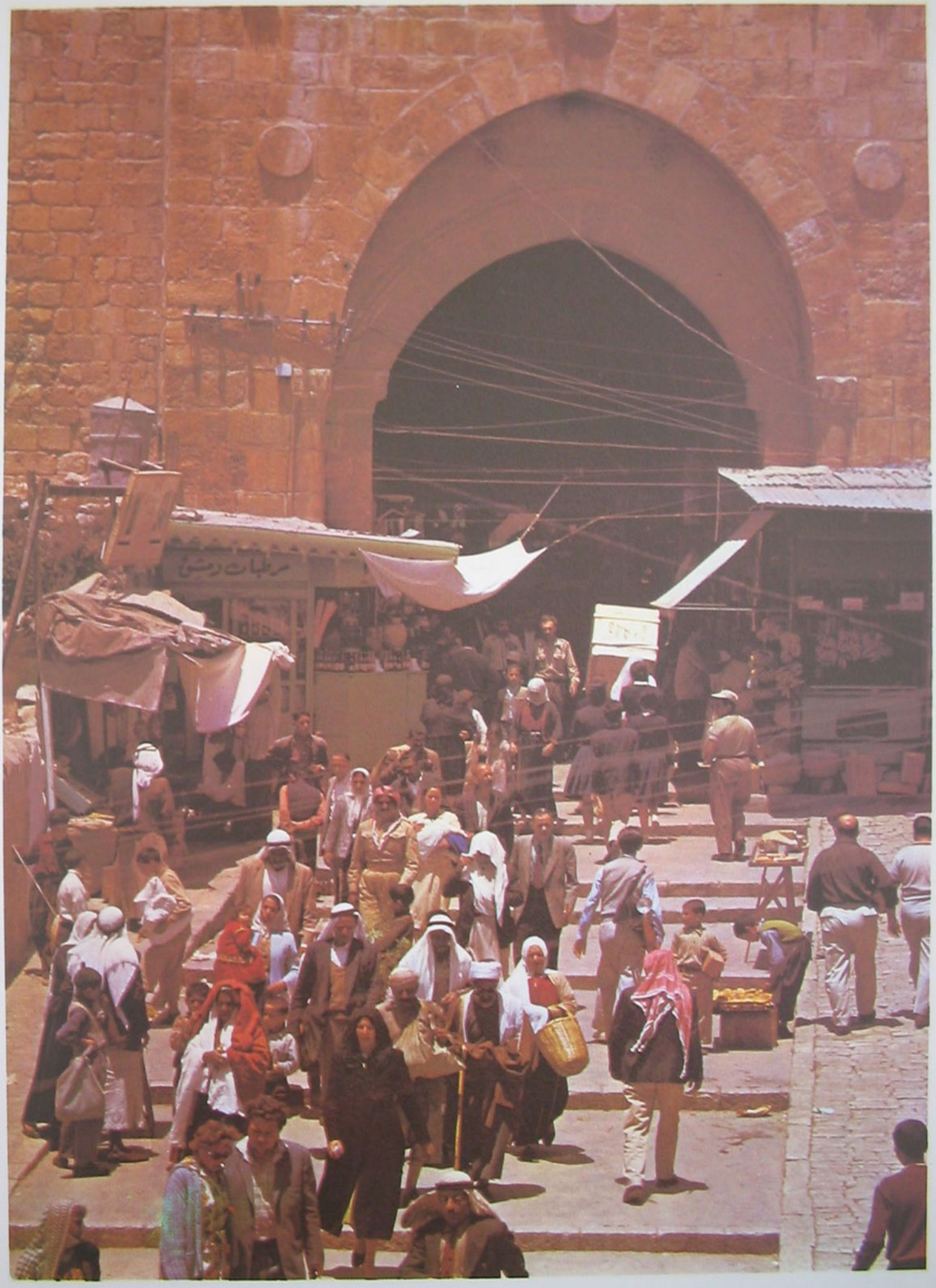
Much of the Middle East is sandy desert that produces few crops. Because of the poor soil and lack of water, Arab people of the area often live in poverty. But petroleum, discovered in parts of the Middle East in the early 1900's, made some of them richer. By the 1960's, Iran, Iraq, Kuwait, Saudi Arabia, Syria and several Arabian sheikhdoms, including Bahrain and Qatar, had large incomes from petroleum. Most Middle Eastern governments allowed foreign companies to extract and export their petroleum after payment of fees called *royalties*.

Many Middle Eastern countries were once part of the Turkish empire. After Turkey collapsed in 1918, France and Britain dominated the area.

When British forces quit Palestine in 1948, the Jews established the state of Israel. No Arabs accepted this state. The Israelis fought and defeated Arab armies in 1948, 1956, and 1967, and each time extended the area of Israeli-occupied territory. The important Suez Canal, built in 1869, was closed after the Arab-Israeli war of 1967. Another war between Israel and her Arab neighbours broke out in October 1973. The Egyptian army swiftly regained some territory east of the Suez Canal, but Israel struck back on the western bank of the canal. Syria lost more territory to the Israelis. (See Arabia; Cyprus; Egypt; Iraq; Israel.)

Midlothian (area 366 square miles) is a lowland county of Scotland, situated south of the Firth of Forth. Its population is 453,000.

Opposite: A crowded street by Jerusalem's Damascus gate. Since ancient times cities' gates have been market places, labour exchanges and even 'law courts' in Middle Eastern towns.



It has not yet been discovered how animals find their way when they migrate. The young cuckoo flies south from Britain to Africa for the first time after its parents have already departed. How it manages to find its way remains a mystery. Migratory birds do not always fly in a straight line as might be expected. They may make wide detours to avoid mountains or deserts.

Midlothian is low-lying in the north, but rises to about 2,000 feet in the Moorfoot Hills and the Pentland Hills in the south. A number of short rivers, including the Gala, North and South Esk, Almond and Water of Leith, drain the county. In the north, dairy farming and market gardening are important. There are also coal and oil-shale mines.

The county was once called Edinburghshire, and this is reflected in the fact that four out of every five people in the county live in Edinburgh, the county town. Other towns include Dalkeith, Musselburgh, Penicuik and Portobello.

Migration In the summer, swallows are common in the temperate (cool) parts of the northern hemisphere—in northern Europe and North America, for instance. But these birds spend the northern winter in tropical and semi-tropical regions—such as parts of Africa and South America. Each autumn they travel south; each spring they fly north again. This is an example of *migration*: the regular to-

A map showing some of the most important bird migration routes.

and-fro movement of an animal from one region to another.

The advantages of migration to the swallow are easy to see. It avoids the cold of the northern winter, when food is scarce. It also avoids the hot summers of the tropics. Migration is even more vital to amphibians. Frogs, toads and newts live most of their lives on land, but they must return to water to breed. As a result, each spring, a migration takes place to local pools and rivers. But compared with the journeys of the swallow, the distances amphibians cover are very small.

Migrations are common among animals living in polar regions or on high mountainous slopes. They avoid harsh winters by moving southwards or to lower levels. The caribou of the northern tundra and mountain sheep and goats are examples of such *migrants* (animals that migrate). The greatest migrant of all is the Arctic tern. This bird flies as much as 22,000 miles in a year—from the Arctic to the Antarctic and back again.

Many fish are also great migrants, often swimming great distances to breed. Cod seasonally move to the north-west Atlantic to spawn. Salmon and sturgeon swim from the sea into freshwater rivers, and the European freshwater eel may migrate 3,000 miles to the Sargasso Sea to spawn. Whales also migrate; for example, the humpback whale moves from the seas around Australia and New Zealand to the Antarctic, following the colder water.

Some creatures make an occasional mass movement to another region, but do not do so regularly and do not return. This is called *emigration*, and usually takes place when the numbers of a particular species build up in a certain area, causing overcrowding. The lemmings of the Arctic are famous for their periodic emigrations, during which many of them rush into the sea and are drowned. A periodic emigration brought the brown rat to Europe from Asia in 1773.

Part of the vast Piazza del Duomo, or Cathedral Square, in the centre of Milan.

Milan is a city in northern Italy. It is situated in the Lombardy plain on the River Olona. It is the chief commercial and financial centre in Italy and in size (pop. 1,713,000) second only to Rome. Lombardy is a fertile agricultural area, and the chief industries of the city include textiles, machinery and chemicals. Milan is a cultural centre and possesses many fine works of art. The mammoth Duomo (cathedral), one of the best Gothic buildings in Europe, is encased in white marble and ornamented with innumerable turrets, pinnacles and statues. Nearby is the famous La Scala opera house.

Milk is an important food obtained from cows, and also from sheep, goats and camels. Other products—butter, cream and cheese—are obtained from milk. These foods are good for us because they contain many substances necessary for our health. These substances include the proteins that we need to build our bodies; fat (which is used to make cream, butter and cheese) to give us energy; carbohydrates or milk sugar, also for energy; essential minerals, such as calcium; and vitamins. (See Dairy farming.)

Milky Way On a clear night, a faint band of light can be seen stretching across the sky—the Milky Way. When seen through even a pair of binoculars, the 'milkiness' disappears, and the faint light

From the Earth we have an end-on view of the Milky Way, since the Earth is itself part of the galaxy.

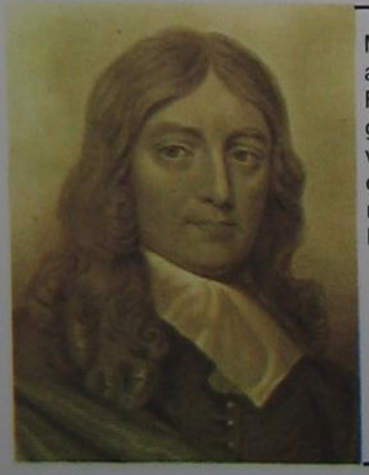
can be seen to come from millions of stars clustered closely together. The Milky Way is a galaxy, and astronomers estimate that it contains about 200,000 million stars.

The Milky Way galaxy is shaped rather like a convex lens, a vast disc, thin at the edges with a central bulge. The distance across the Milky Way is 100,000 light-years.

On Earth we get an end-on view of the disc of the Milky Way, because the Earth itself is part of the disc. This explains why the Milky Way appears as a long thin band, its brightest portion being in the direction of the centre of the galaxy. Stars in the Milky Way are slowly rotating about its centre.

The Milky Way system is in fact a typical example of a *spiral* galaxy. It is so faint that it can be seen only on a really clear night.

Milton, John (1608-1674), an English poet, is remembered mainly for his great epic poem *Paradise Lost*. In addition to his poems, he also wrote many political pamphlets.



Milton as a young man, after a miniature by Faithorne. As an undergraduate at Cambridge he was nicknamed the 'Lady of Christ's' because of his rather effeminate good looks.

Milton was born in London, where his father was a *scrivener* (writer) and a composer of music. As a boy he attended St. Paul's School, and later went to Christ's College, Cambridge, where he wrote several poems in Latin, and *On the Death of a Fair Infant*. But his first really distinctive poem, *On the Morning of Christ's Nativity*, appeared in 1629.

In 1632 Milton took his degree and left Cambridge for Horton, his father's home in Bucks, where he spent the next six years reading and studying. He probably wrote *L'Allegro* and *Il Penseroso* here. In 1637 he wrote *Lycidas* in memory of his dead friend Edward King. For the next twenty years, until the completion of *Paradise Lost*, the only poems that Milton wrote were sonnets.

In 1638 he travelled abroad, mostly in Italy. On his return he became tutor to his two young nephews and other pupils. In 1641 he joined the political conflict, supporting the Puritans with a series of pamphlets against the power of the bishops. A year later he married Mary Powell, who came from a Royalist family. They were not happy, and shortly after the marriage Mary returned to her parents' home. The Civil War broke out and she did not join Milton again for three years, during which he wrote several pamphlets advocating divorce. He also wrote the *Areopagitica*, on the freedom of the Press.

What in me is dark
Illumine; what is low raise and support;
That to the height of this great argument
I may assert eternal Providence,
And justify the ways of God to Men.

John Milton: *Paradise Lost*

After the execution of Charles I, Milton was appointed Latin Secretary to the new Council of State. His sight was deteriorating and by 1652 he was totally blind. In the same year his wife died, leaving three daughters. In 1656 he married Catharine Woodcock, who died two years later.

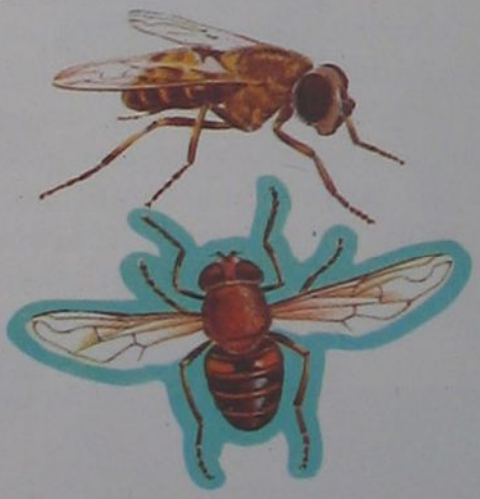
At the Restoration, Milton was arrested, fined and released, though he lost most of his fortune. He married Elizabeth Minshull in 1663 and completed three of his greatest works, *Paradise Lost*, *Paradise Regained* and *Samson Agonistes*, in his final years.

An example of mimicry. The two butterflies are of different species but they share a colour pattern. Both taste unpleasant.

Mimicry occurs when one animal closely resembles the appearance of another animal of a different *species* (kind). Mimicry benefits an animal in some way. Usually it protects it from its *predators* (other animals that feed on it).

For instance, suppose that some species of insect is unpleasant to birds, perhaps because it smells or tastes bad or because it stings. Many unpleasant species have bright colouring that makes them distinctive. Such *warning coloration*, as it is called, acts as a warning to predators. Birds who learn to avoid members of that species will also avoid members of another species that look the same, even if they do not have the unpleasant characteristics.

The animals that are 'copied' are called the *models*. Those that gain protection are called the *mimics*. Obviously, for this kind of mimicry to work, both model and mimic must live in the same area and mix freely. And the mimic must copy the *behaviour* (actions) as well as the appearance of the model. Otherwise, predators would learn to distinguish be-



Bees and wasps are mimicked by many insects. The Drone fly (above) is a true fly, but when feeding from flowers it looks very much like a bee (below).

tween them despite their similar appearance. Furthermore, the mimic must be much less common than the model. Otherwise, the predator would associate the particular coloration with the mimic (good to eat) rather than the model (bad), and both would be eaten.

In another kind of mimicry, however, both models and mimics are common, and both are distasteful to predators. In this way, both species gain protection because predators more quickly associate their colouring with unpleasant characteristics.

Mimicry may also be used to disguise attack. In this kind of mimicry, the predator mimics its prey so that it can have the element of surprise in its favour. The most remarkable examples of this are among the assassin bugs, carnivorous insects that eat other insects. They are remarkably like their prey, to the smallest detail—some species resemble stick insects, others look like mosquitoes, while others even resemble the praying mantis. Assassin bugs can even deceive human collectors.

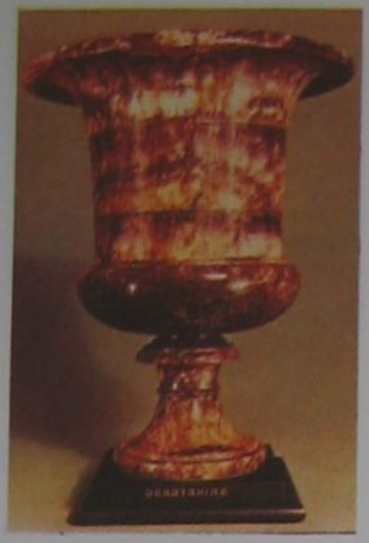
Minerals are substances which make up the rocks of the Earth. Anything not animal or vegetable is mineral. Animal and vegetable matter consists of living or once-living material. But minerals have no life.

Some minerals are composed of single elements, such as copper, gold and sulphur. Others are composed of two or more elements, such as mica and quartz.

True minerals, being non-living substances, are *inorganic*. Petroleum, coal

Some of the Mineral Sources of Metals

1. Pyrolusite (an ore of manganese)
2. Wulfenite (an ore of molybdenum)
3. Haematite (an ore of iron)
4. Carnotite (an ore of uranium)
5. Rutile (an ore of titanium)
6. Limonite (an ore of iron)
7. Psilomelane (an ore of manganese)
8. Rhodocrusite (an ore of manganese)
9. Iron Pyrites (Fool's Gold)
10. Cassiterite (the ore of tin)
11. Magnetite (an ore of iron)



A vase made from a variety (known as 'Blue John') of the mineral fluorite. It is 18½ inches high, and of banded purple and yellow fluorite.

and similar materials are composed of *organic* (once-living) matter and are therefore not true minerals. But generally they are called minerals. Many minerals are metals. Non-metallic minerals include carbon, quartz and sulphur.

Finding and indentifying minerals is important, because many minerals are used to make things which we use daily. Scientists have classified more than 2,000 minerals. But only 30 are common in most rocks.

In a pure form, a mineral is *homogeneous*—that is, every part of it is the same as every other part. When scientists want to identify a mineral, they can examine certain features, such as its hardness, colour and the amount of light that passes through it. For example, hardness is measured against a table in which talc, the softest mineral, is No 1, and diamond, the hardest mineral, is No 10. The hardness of a mineral can be roughly determined without scientific instruments. If you can scratch a mineral with your fingernail, then the mineral has a hardness of 2·5 or less. A piece of glass can scratch a mineral of a hardness of 5·5 and the blade of a knife about 6·5.

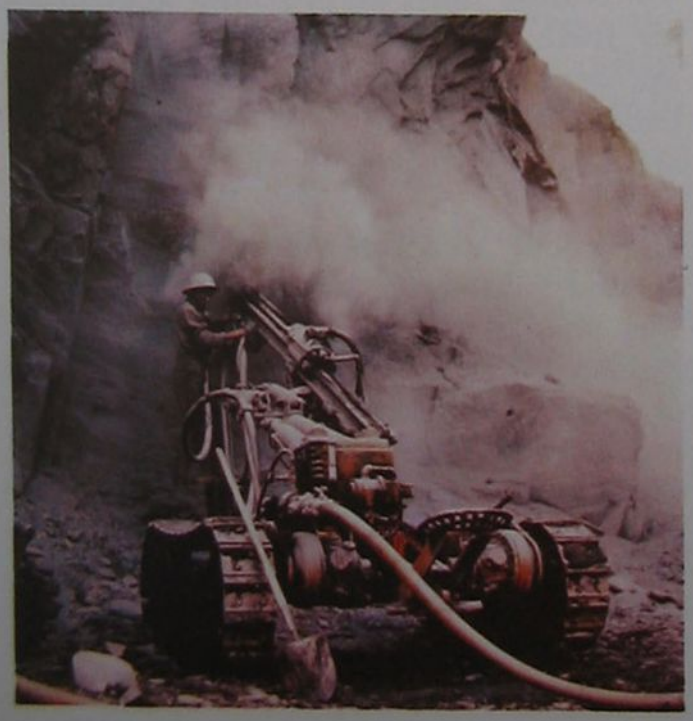
Another way of indentifying a mineral is to examine its crystals. The smallest particles in most minerals are arranged in crystals. A few minerals are *non-crystalline*, having no definite shape.

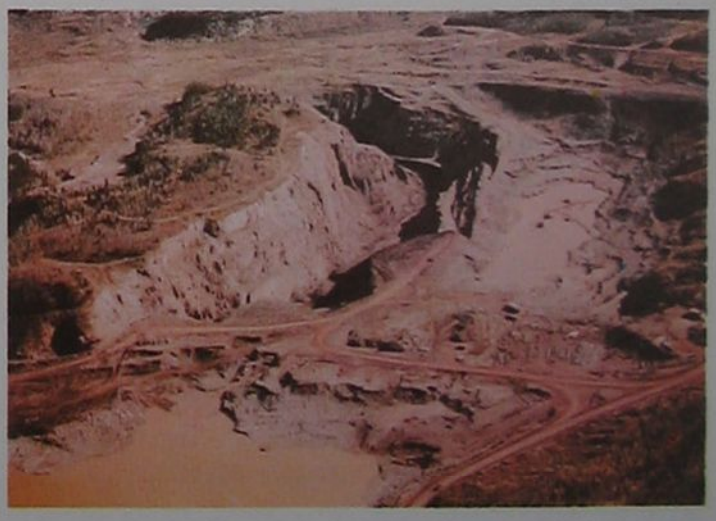
Some minerals are easy to identify. Others resemble each other so closely that several tests are needed to distinguish between them.

Mining All the vital raw materials for modern industry, such as coal and iron ore, come from the ground.

Mining—taking these minerals from the ground—is one of the most important industries in practically every country. The leading industrial nations, especially the United States and Russia, have become powerful because of their vast mineral resources.

Some mineral deposits lie on or near





Above: An open-cast (surface) iron ore mine in Canada.

Left: If the ore deposit lies beneath the surface, the covering or *overburden* has first to be removed. This bulldozer is stripping the overburden from a rock face.

Above: Drilling the shot-holes—underhand stoping in metal mining.

Left: In underground mining the holes are drilled in a special pattern and packed with explosives, so that a certain amount of ore is loosened when the charges are detonated.

the surface or in the beds of rivers or lakes. But others lie thousands of feet underground. In South Africa gold is mined almost two miles down.

Surface mining is by far the easiest and cheapest way of mining. The ore deposit is simply scooped up by massive power shovels and dropped into trucks. If it lies beneath a layer of earth, this *overburden* is stripped off first. Also, the ore may have to be broken up by explosives before it can be shovelled. This kind of mining is called open-cast, open-cut, or strip mining. The disadvantage of this type of mining is that it devastates large areas of land. Land which has been mined by open-cast methods will not support any growth for many years after the mine has ceased to operate.

Mineral deposits in the gravel of river and lake beds are called placers. Heavy minerals, such as gold and tin ore (cassiterite) are often found in placers. Placer mining involves dredging the gravel and washing it with jets of water. The heavy ore remains, while lighter material is washed away.

In underground mining, vertical shafts are sunk down into the ground. Tunnels are dug horizontally from the shafts to the ore deposits. The ore is loosened by blasting and lifted to the surface. In large mines, miners and ore are carried along the tunnels by railway. Lifts called cages transport them to and from the surface. Increasing use is being made of machinery in mines, especially coal mines. (See Coal.)

Underground mining is expensive because of all the equipment needed. Ventilation must be provided to keep the air fresh. The tunnels must be *shored-up*, or supported, to prevent them from collapsing. Even so, rock falls are a constant danger, especially in deep mines.

Minnesota is a midwestern state in the United States, on the Canadian border. The state is rich in both agriculture and industry. Farms produce large quantities of maize, wheat and soya-beans on the fertile land. Many dairy cattle are raised. Over half the iron ore in the U.S. comes from the mines of Minnesota. Factories process food, build machinery and produce paper. Because of its varied and beautiful scenery, the state attracts many sportsmen and holidaymakers.

This location map shows the position of Minnesota.

About two-thirds of Minnesota's 3,805,000 residents live in cities, especially the 'Twin Cities' of Minneapolis and St. Paul. St. Paul is the state capital, but Minneapolis is the chief city. Ships carry goods from the Twin Cities all the way down the Mississippi River to the Gulf of Mexico. Other ships reach the Atlantic Ocean from Duluth by way of the St. Lawrence Seaway.

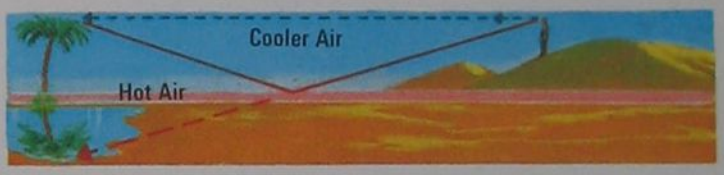
The known history of Minnesota dates back to the arrival of French fur-traders in the 1600's. France ceded the region to Britain in 1763, and the U.S. gained control of it after the War of 1812. Minnesota became a state in 1858.

Mirage In desert areas a layer of hot air lying just above the ground can have a layer of cool air above it. When this happens rays of light from some distant object, such as a grove of trees, can be reflected downwards from the bottom surface of the cool air. The rays of light can then be seen as an upside-down image of the trees, looking very much as if they were being reflected in a nearby pool of water. This effect is known as an *inferior mirage*.

Even more spectacular mirages can be seen at sea. They may take the form of a ship floating in the air, or the lights of a city shining in the sky. This kind of mirage (called a *superior mirage*) is caused when a layer of *cool* air just above the sea surface has a layer of *warm* air above it. Then light rays from a far distant ship or coastal town are reflected downwards from the bottom surface of the warm air.

Normally light passing from one transparent material into another, or from warm air into cool air (or vice-versa) is bent or *refracted*. If the light rays strike the surface of the transparent material at a very small angle, however, they will be *reflected* rather than be refracted. A mirage is formed when light rays strike the distant air surface at a small angle, called the *angle of internal reflection*.

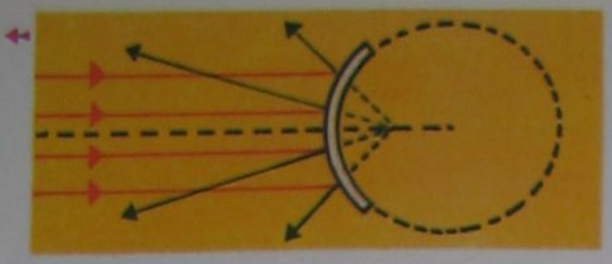
A superior mirage is caused by a layer of warm air situated above a cooler layer over the surface of the sea. Light rays are reflected downwards from the bottom surface of the warm air.



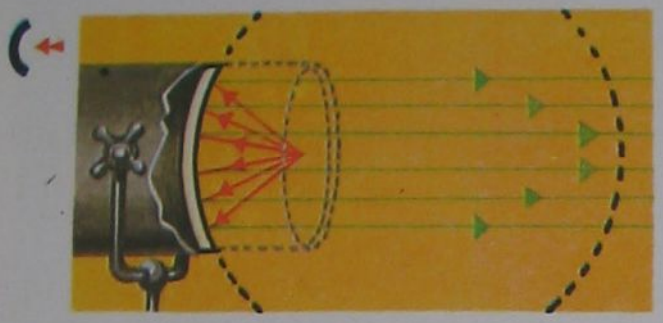
An inferior mirage is caused when a layer of hot air on the surface of the earth has a cooler layer above it. The image is reflected downwards from the bottom surface of the cool air.

Mirrors Every surface reflects light to some extent. A sheet of white paper absorbs about a fifth of the light striking it and reflects back the remaining four-fifths. Light reflected from paper is scattered in all directions. A mirror, however, reflects light evenly from its smooth and polished surface. A ray of light striking a flat or *plane* mirror behaves like a ball striking a wall; it bounces back at the same angle (called the *angle of reflection*) with which it made contact (the *angle of incidence*).

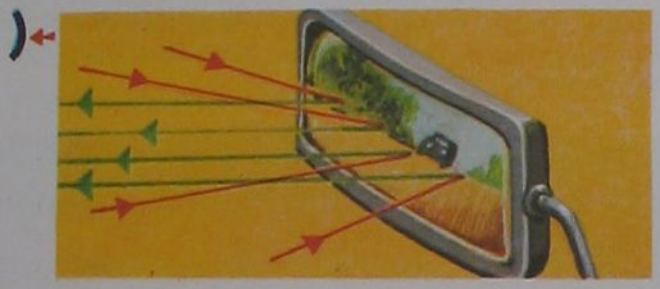
The reflection of anything seen in a mirror is called an *image*. Multiple images can be formed in a *Kaleidoscope* using two plane mirrors placed at an angle of 60°



When light rays travelling parallel to the principal axis of a *convex* mirror are reflected they diverge. But all appear to originate from a point behind the mirror—an imaginary focal point.



Searchlights and car headlights use *concave* mirrors. A light source is placed at the principal focus and those rays which strike the mirror are reflected as a parallel beam.



Some driving mirrors are convex. They gather in light from a wide surrounding area, and direct the rays to the driver's eye. In this way he can see a diminished image of the whole road behind him.

in a long tube. Pieces of coloured glass placed at one end of the tube can be seen as elaborate symmetrical patterns on looking through the other end.

The surface of a *concave* mirror is curved inwards, like the bowl of a spoon. Rays of light striking the surface of a concave mirror are reflected back to a point called a *focus*. They then spread out from the focus and can form an enlarged image of an object being reflected. Because the image can be focused on to a screen it is called a *real image*. Concave mirrors are used in telescopes. The large concave mirror used in the giant astronomical telescope at Mount Palomar in California is 200 inches in diameter.

The surface of a *convex* mirror is curved outwards, like the back of a spoon. Rays of light spread outwards from a convex mirror's surface on reflection. An image reduced in size is seen in a convex mirror, and that is why it can be used as a driving mirror. The image is called *unreal*, however, because it cannot be focused on to a screen.

Mississippi, a state in the United States, is part of the Old South. It has a short coastline on the Gulf of Mexico. Along its western border is the great river from which it takes its name. The river is both a blessing and a threat for the people of the state. It carries rich silt which makes the land fertile, but it also causes floods that destroy life and property.

The climate of the state is warm and moist and suitable for growing cotton, the state's most important farm product. Soyabeans, poultry and beef cattle are also produced. The lumber industry provides paper, tar and turpentine. Mineral resources include petroleum and natural gas.

The population of Mississippi is just under 2,217,000. The capital and largest city is Jackson.

Mississippi was explored by Spaniards in 1540, and settled by the French from 1699. British troops defeated the French in 1763. Mississippi entered the Union in 1817. A slave-holding state with a plantation economy, it fought on the Confederate side in the Civil War.

This location map shows the location of Mississippi.

A paddle steamer on the Mississippi. Boats like these were once common on the great river, and many were notorious for gambling and drinking.

Mississippi This is the longest river in the United States and, with the Missouri, forms one of the longest river systems in the world. It drains a huge basin of about one-and-a-quarter million square miles between the Rockies and the Appalachians.

The Mississippi rises close to the northern border of the United States, in the lake region of north Minnesota. It flows through swampy land to St Anthony Falls at Minneapolis. From there to its mouth at the Gulf of Mexico it is fed by more than 250 tributaries. Its whole course winds for about 2,350 miles.

The Mississippi is joined by its famous partner, the Missouri, just north of St Louis. At first their waters scarcely mix and the two rivers flow side by side in the same bed for several miles. Their combined length is about 3,700 miles, and the entire river system provides about 14,000 miles of navigable waterways.

In its lower course the Mississippi meanders across a wide flood plain that is extremely fertile in parts. Finally, after flowing through a large area of swamps and lakes, the river discharges its waters into the Gulf of Mexico. At high water it pours about 2,300,000 cubic feet of water a second into the Gulf.

Large areas of the Mississippi valley are regularly drowned in violent floods caused by heavy rains, in spite of a series of dams and *levees* (embankments).

The Mississippi was discovered in 1541, near Memphis, Tennessee, by the Spanish explorer Hernando de Soto.

Missouri is a state in the midwestern United States. It is famed for its beautiful Ozark Mountains and for its two great rivers, the Mississippi and Missouri. These rivers provide transport and hydroelectric power, making Missouri an important industrial and commercial state. In pioneer days, Missouri was the starting point for important overland routes to the West.

This location map shows the position of Missouri.

Missouri has a population of 4,677,000. Jefferson City is the capital, but St. Louis and Kansas City are the largest cities. Their factories produce transport equipment, processed food, chemicals and shoes. Lead is the state's most important mineral. Farmers raise livestock, and grow maize and soya-beans.

France claimed Missouri after exploring the region in 1673 and 1682. The U.S. acquired it in 1803, and granted it statehood in 1821. Despite many conflicts between slavery and anti-slavery interests, Missouri remained loyal to the Union during the Civil War.

Mogul or Mughal is the name of the *dynasty* (series of rulers of the same family) that flourished in northern and central India in the 1500's and 1600's. The empire was famous for its magnificence and stability.

It began with *Babar*, a Muslim prince of what is now Afghanistan. He invaded northern India, captured Delhi and Agra (which became the centres of Mogul rule) and brilliantly defeated the Hindu princes opposing him in 1526.

His grandson *Akbar the Great*, who ruled from 1556 to 1605, established a central government for the first time. His reign was noted for its encouragement and development of the arts, legal reform and religious toleration. But as a backcloth to these peaceful pursuits, there was almost continual warfare. Expansion of the empire's frontiers was brought about through ruthless conquest.

The reign of Akbar's son *Jahangir*, from 1605 to 1627, marked a decline in the military fortunes of the empire. The most famous memorial of *Shah Jahan*, Jahangir's son, who ruled from 1627 to 1658, was the Taj Mahal, which he built as a tomb for his wife. His reign saw the peak of Mogul power and magnificence.

The Mogul empire began to break up in the early 1700's as a result of British and French influence in India.

Mohammed (A.D. 570-632) was a great religious leader and founder of the religion called Islam. Muhammad and Mahomet are other spellings of his name. His followers are called Muslims.

Mohammed was a merchant in the Arab city of Mecca. He spent much of his time wandering alone in the mountains nearby. One day while he walked on the slopes of Mount Hira, he had a vision of the Angel Gabriel commanding him to preach the 'true' religion. He doubted at first that the vision came from God. But when Gabriel appeared to him a second time, he gave up his merchant's trade and began to preach in Mecca.

Most Arabs of Mohammed's time were pagans who worshipped many gods and prayed to idols and spirits. Mohammed spoke to them of one God who requires that men give 'Islam', or complete obedience, to him.

The Meccans hated Mohammed for his claims and for his attacks on their way of life. But the people of Medina, another Arabian city, made pilgrimages to Mecca to hear him. Finally he went to Medina and became ruler of the city.

Eight years later he returned triumphantly to Mecca, marching at the head of ten thousand men. This time he was welcomed as a Prophet.

Opposite: Akbar, the Mogul emperor, on his elephant Hanai. The Moguls were famous for their encouragement of the arts.

The great religious movement begun in Arabia spread, after Mohammed's death, to other parts of the Middle East, northern Africa, and Asia. Today, there are about 479 million Muslims.

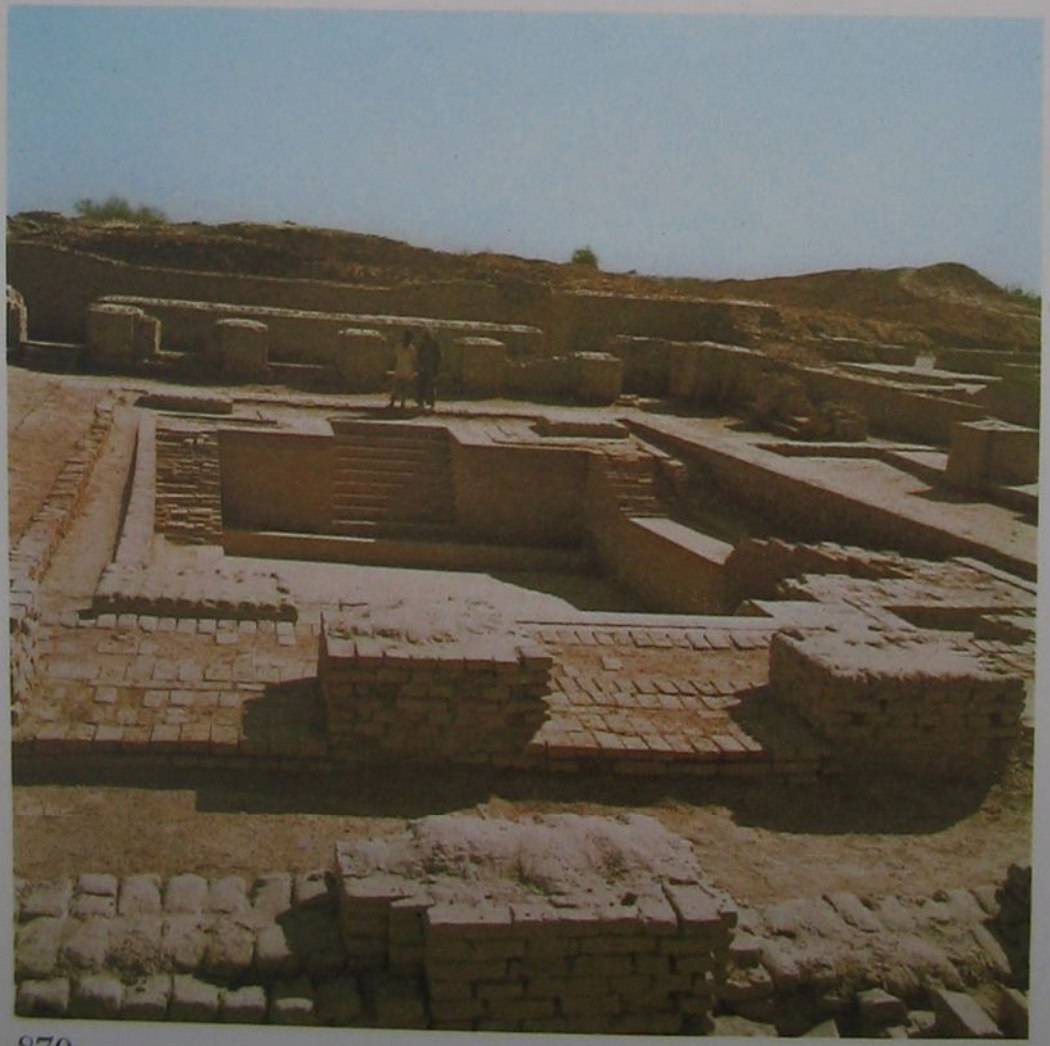
Muslims do not worship Mohammed, but believe him to be the last messenger of God, completer of the sacred teachings of such earlier Prophets as Abraham and Moses, the founders of Judaism, and Jesus Christ, the founder of Christianity. (See Islam.)

Mohenjo-daro The earliest known cities in India were in the valley of the River Indus. The remains of a number of different settlements have been discovered by archaeologists. They are scattered over an area a thousand miles long. The two biggest cities were called Mohenjo-daro and Harappa. These cities were inhabited from about 2500 to 1700 B.C. They are not as old as the Egyptian cities of the Nile, or the cities of Mesopotamia, but they reveal a remarkable civilization.

Mohenjo-daro was more than three miles in circumference. It had a citadel with a wall and towers surrounding it, a grain store, and streets lined with houses. The buildings were made of bricks which were fired in a kiln, not just baked in the sun. Rich men's houses had baths, drains and water tanks. There was a large public swimming bath. Perhaps this bath had something to do with religion; cleanliness has been of great importance in later Indian religion.

Archaeologists have discovered a great deal about the daily life of the people of Mohenjo-daro. We know that they could spin and weave and use a potter's wheel. They used bronze and made jewellery of silver, ivory and gold. Seals with picture writing have been found; but nobody has yet been able to read this writing.

Exactly why these cities were deserted is not yet known. There are signs that the Indus flooded and often overflowed into Mohenjo-daro in its later years. There



The Great Bath at Mohenjo-daro, one of the largest cities of the Indus Valley civilization. Archaeologists think that this bath may have had some religious significance.

King William III was killed by a fall from his horse which stumbled on a mole hill. Supporters of the exiled Stuart King, who hoped his death would help their cause, drank toasts to the mole as 'the little gentleman in black velvet'.

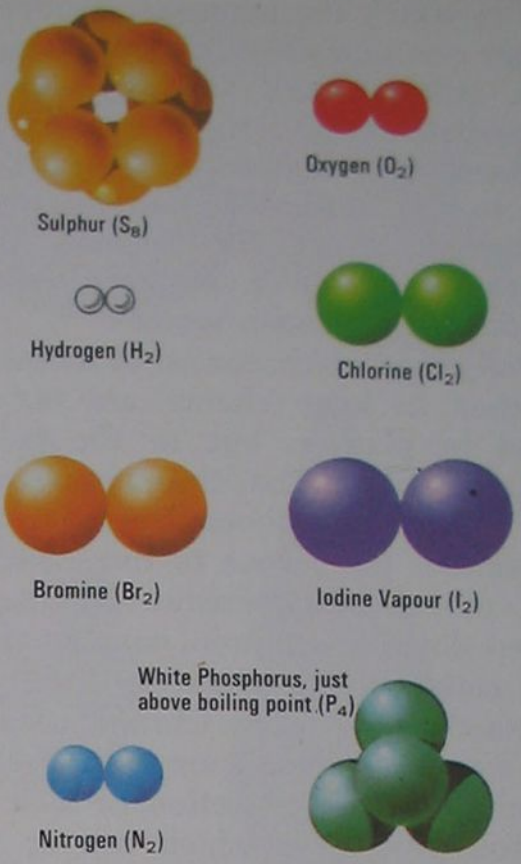
are also signs that invading tribes attacked the cities and killed or drove out the inhabitants. There is a great deal more to be found out about these ancient cities and their way of life.

Mojave Desert is in California, in the western United States. It consists of sand, volcanic ash and rock, and dry lake beds. Its total area is about 15,000 square miles. Although the Mojave appears to be a wasteland, it is the source of a number of useful minerals. These include metals such as gold, silver, iron and tungsten.

Mole The mole is a small mammal with soft fur that lives almost entirely underground. Moles are tireless diggers, using their powerful clawed front feet to loosen the earth, which they then shovel back with their hind feet. They search for food as they burrow, eating mainly earthworms and grubs. They have a great appetite, eating twice their own weight each day.

Moles are almost blind, but they have good hearing. Their ears have no flaps. Moles are around six inches long, with pointed snouts and short tails. Various species live in Asia north of the Himalayas, Europe and North America.

A placental mole (above) and (below) a marsupial mole. Long snouts and powerful claws give these two burrowing animals a remarkably similar appearance even though they are not related.



Molecules can be of two kinds—where all the atoms they contain are of the same element, and where they are of different elements. The molecules shown above are all molecules of elements.

Molecule Two or more atoms joined together can form a *molecule*. In molecules of *elements* all the atoms are of the same kind. When atoms of molecules are of different kinds we have *compounds*. The element *oxygen* in the air we breathe, for example, consists of molecules of just oxygen atoms. *Carbon dioxide* gas, however, is a compound and consists of molecules containing carbon and oxygen atoms.

The same kinds of atom can be joined together to form different molecules of different compounds. Atoms of carbon and hydrogen, for example, can form molecules of the gas *butane* (used in lighters), the liquid *benzene* (used to show up watermarks in stamps), the solid *naphthalene* (used to make mothballs) and many other compounds belonging to an important group of chemical substances called the *hydrocarbons*.

In both elements and compounds the

way in which the atoms are grouped together can determine the hardness, softness, colour, smell and other *physical* properties which they possess. The hardness of a diamond, for example, is due to the 'girder-like' arrangement of its carbon atoms. The 'rubbery' plastic *polythene* is made of very long 'chains' of carbon and hydrogen atoms.

Molecules which consist of atoms held together in long 'chains' are not only found in plastics, but in the cells of living creatures. The 'chromosome molecule' DNA (deoxyribonucleic acid), which determines the colour of the eyes, hair, and other characteristics of parents passed down to children, consists of very long coiled chains made up from many thousands of atoms (see Chromosome).

In a molecule atoms are either held together by mutual attraction, or by a complicated process in which two or more atoms can 'share' the same electrons. The 'links' between atoms in molecules are called *chemical bonds*. In the diagrams used to explain how atoms are grouped together to form a particular molecule a chemical bond is shown by a short line.

Molluscs are a large and varied group of animals that include snails, slugs, limpets, oysters, mussels, cuttlefish, octopuses and squids. The body of a mollusc is soft and has no backbone, but most molluscs have a hard outer shell. In some molluscs, such as cuttlefish and squids, the shell is inside the body, and a few such as some slugs, have no shells. The shell varies in size from a fraction of an inch up to four feet in the case of a giant clam. Unlike arthropod animals, such as insects and crustaceans, a mollusc does not break out of its shell and grow a new one as it develops. The shell simply grows as the mollusc grows. It is built up of limestone that the mollusc obtains from its surroundings. Mollusc shells may have beautiful patterns and colours, and the inside may have a shimmering iridescence produced by the substance *nacre*, or mother-of-pearl.

There are five main classes of molluscs: chitons, tooth shells or tusk shells, gasteropods, bivalves and cephalopods. Next to insects, molluscs are the most numerous of animals. The thousands of shells you can see on beaches are mollusc shells.

Chitons have shells consisting of eight plates and can roll themselves into a ball like the woodlice they resemble. Chitons, also called *coat-of-mail shells*, live on the sea-bed and scrape up food with a rasp-like tongue called a *radula*.

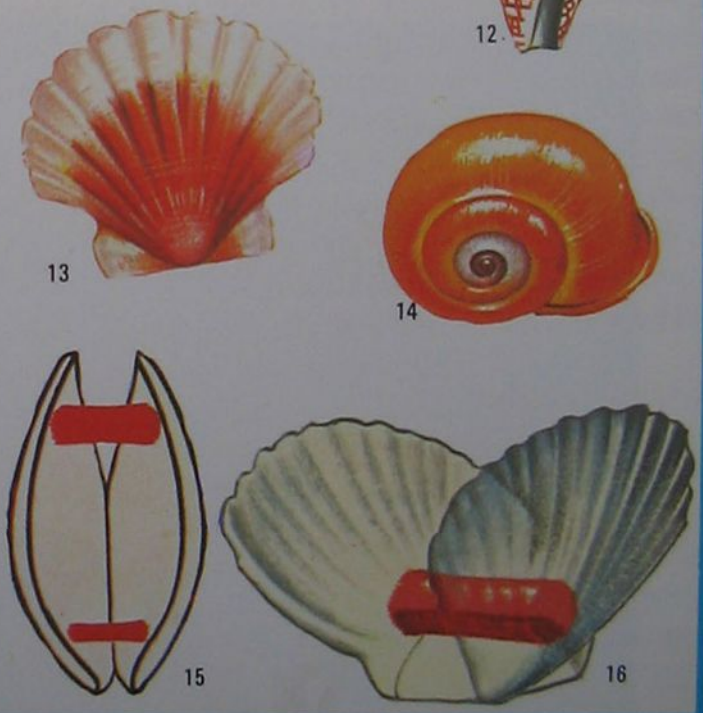
Tooth shells, or *tusk shells*, resemble short tusks. They live in the sea, burrowing into sand and mud. The shell is open at both ends.

Gasteropods are single-shelled molluscs. Marine gasteropods include limpets, abalones (ormers, or ear-shells), cowries, whelks and many others. Snails and slugs are land gasteropods. Gasteropods extend their head and foot outside the shell, but can withdraw them quickly if danger threatens. Snails and slugs have two pairs of tentacles on the head. One pair bears eyes and the other, smaller pair is used to smell. Marine gasteropods have one pair of tentacles with eyes at the base. All gasteropods move around on a flat gliding foot. Land snails and slugs breathe by means of lungs, whereas marine gasteropods have gills to breathe underwater. Some snails live in fresh water. They possess either lungs, in which case they must come to the surface for air, or gills. Gasteropods feed on plant or animal material which they rasp away with the radula.

Bivalve molluscs have two shells. They are also called *lamellibranchs*. The two shells, or valves, are connected by a piece of elastic tissue called a *ligament*. One or two strong muscles close the shell. When the muscles relax, the ligament opens the shell. Bivalves are aquatic creatures, living mainly in the sea, although some inhabit fresh water. They include mussels, razor shells, cockles, clams, scallops and oysters. Unlike gasteropods, bivalves

Some Varieties of Molluscs

1. The shell of a typical snail. The inner walls of the shell join to form the central *columella*, which is a hollow tube.
2. The shell of Nautilus.
3. Partly cut-away section through Nautilus.
4. Tusk shell.
5. The Round-mouthed Snail *(Pomatias elegans)*.
6. The same snail at rest, with the opening of the shell closed by the *operculum*.
7. A Dextral ('right-handed') shell.
8. A Sinistral ('left-handed') shell.
9. The *radula* of a snail consists of a mass of horny teeth that is pushed forward to rasp at food.
10. Terebra.
11. Chiton.
12. Cone shell.
13. Scallop.
14. Snail shell.
15. Diagram of a mussel's shell. Two muscles pull the halves of the shell together.
16. Diagram of a scallop's shell. One large muscle pulls the two halves of the shell together.



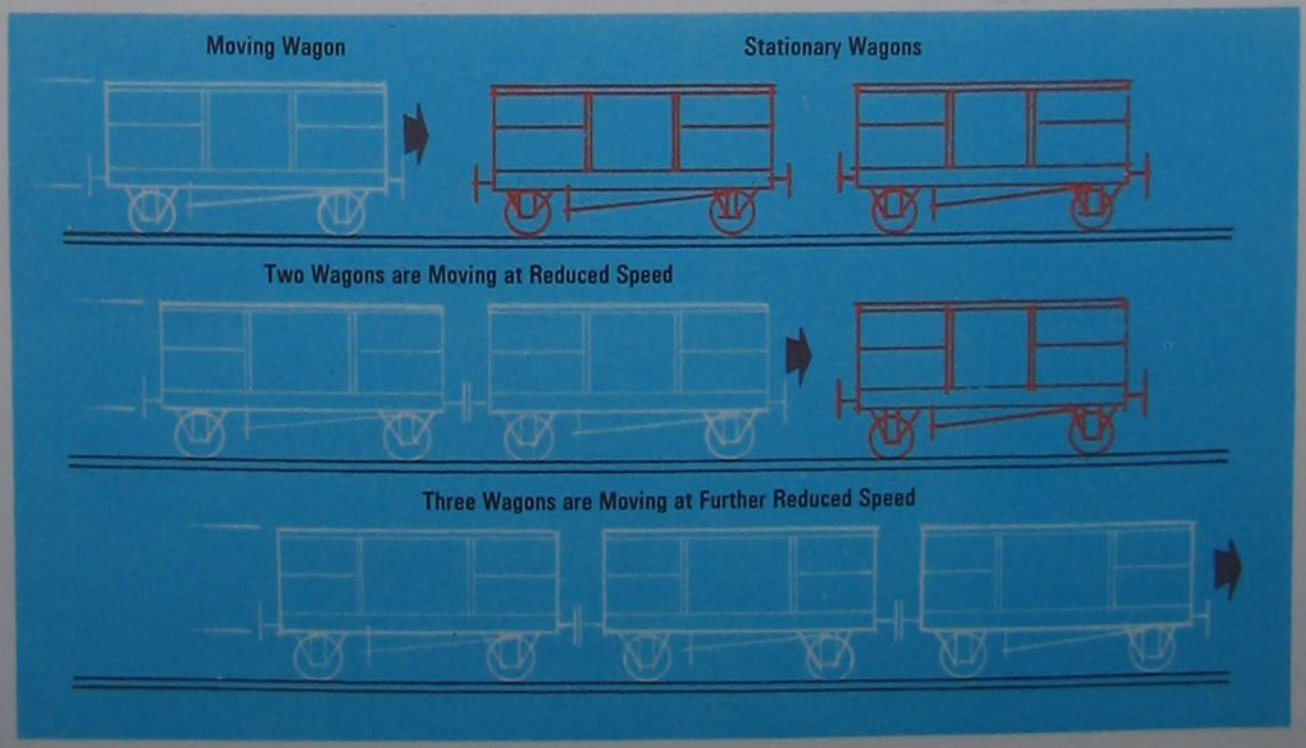
have no head and they feed by straining food particles from the water. Some bivalves, including cockles, move about by using their foot. Cockles can use it to move at the surface, while the razor shell uses its foot to burrow in the sand or mud. Some bivalves, such as mussels, attach themselves to rocks or piers by means of a bundle of strong sticky threads called a *byssus,* and do not move. Oysters have no foot, and one shell is cemented permanently to the sea-bed. Scallops, on the other hand, can move about freely by 'clapping' their shells together and squirting out water. Scallops are also unusual in that they have a row of eyes along the edges of their bodies.

Cephalopod molluscs have an internal shell, or none at all, and a set of arms surrounding the head, which has eyes. Squids and cuttlefish have ten arms and the octopus has eight. They are all marine creatures, and include the largest molluscs. The giant squid may grow to a length of 40 feet or more. Cephalopods use their arms to catch their prey. There are rows of suckers on the arms. The suckers of the cuttlefish have teeth and those of the squid have retractable claws. Cephalopods are difficult to spot in the sea as they can change colour to merge with their surroundings. But if they are attacked, they discharge a cloud of dark ink into the water to hide their escape or to confuse the attacker. (See Octopus.)

Momentum When an object moves, it has *momentum* equal to its mass multiplied by its velocity. A light object, such as a bullet, moving very fast may have more momentum than a heavy object, such as a man, moving only slowly. For this reason, a tiny bullet can have enough momentum to knock down a running man. If someone taps you on the shoulder with a piece of wood, you hardly feel it. But if he swings the wood from high above his head and hits you hard, the blow really hurts. The wood has not got any heavier, but its momentum has increased because it is moving much faster.

Scientists use the concept of momentum in studying what happens when objects hit each other—that is, when they collide. An important principle of physics states that, in a collision, the momentum before impact equals the momentum after impact. This principle is called the con-

Initially one wagon is moving. Then it collides and links up with two stationary wagons. The momentum of the first wagon is shared by the other wagons. Some may, however, be lost in between collisions.


Moving Wagon
Stationary Wagons
Two Wagons are Moving at Reduced Speed
Three Wagons are Moving at Further Reduced Speed

Monte Carlo in Monaco is a fashionable resort and centre of gambling. Each year two of the most famous car races, the Monte Carlo Rally and Grand Prix, are held there.

servation of momentum. Nuclear physicists use it when studying photographs of collisions between atomic particles.

Railwaymen can also make use of momentum when shunting wagons. If a railway truck weighing 10 tons rolls along at 10 miles an hour (so that its momentum is 100 ton-miles an hour) and it hits and links up with a stationary truck weighing 15 tons, what happens? Because momentum is conserved, both trucks must move off in the same direction. Their combined weight is 25 tons. So, because their momentum must still equal 100 ton-miles an hour, they roll along at 4 miles an hour (25 tons × 4 miles an hour equal 100 ton-miles an hour).

We can now see how a revolver is effective. A man weighing 150 pounds and running at 10 miles an hour has a momentum of 1,500 pound-miles an hour. A revolver must fire a bullet with more than this momentum if it is to stop the running man. If the bullet weighs a fifth of a pound, the revolver and cartridge must be designed to fire it with a muzzle velocity of more than 7,500 miles an hour.

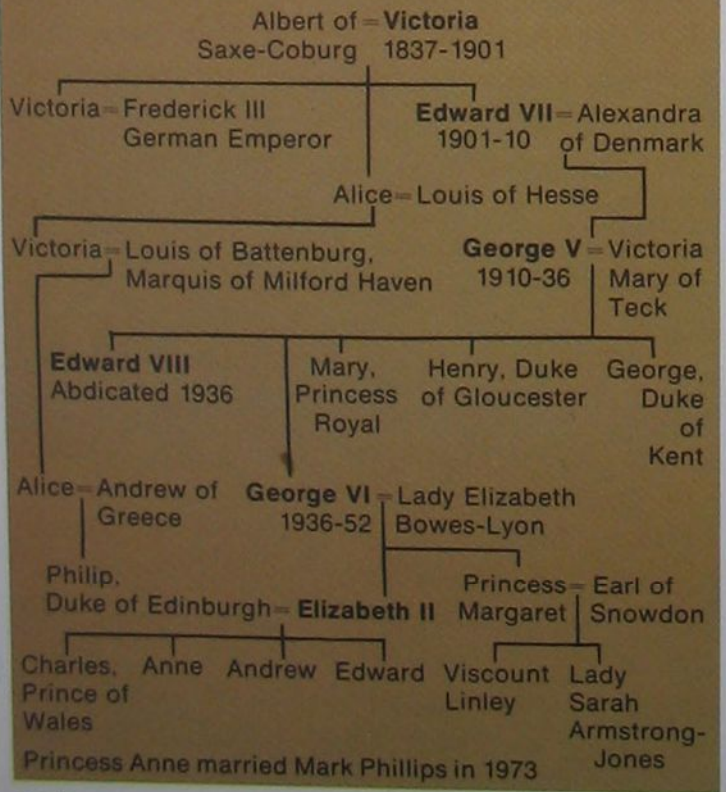
Monaco is a tiny European principality, located on the Mediterranean Sea and otherwise completely surrounded by France. Monte Carlo is the country's famous gambling and holiday resort. Postage stamps bring in additional revenue and the yearly Monaco Grand Prix and Monte Carlo Rally events attract many car racing enthusiasts. Foreign businesses keep their registered offices in Monaco for tax purposes. Perfumes, sweets and chemicals are manufactured in Monaco. The country is under French protection. Internally it is governed by a council under the authority of a prince.

Most of Monaco's 24,000 residents are French. Only about one-seventh are native-born *Monégasques*. Most people speak French or one of its dialects. Monaco was founded by Phoenician traders in 700 BC. The Grimaldi family from Genoa became rulers in 1297. Monaco was an-

KINGS AND QUEENS OF ENGLAND

Anglo-Saxon Kings	A.D.
Egbert	827
Aethelwulf	839
Aethelbald	858
Aethelberht	860
Aethelred I	865
Alfred	871
Edward I	899
Athelstan	924
Edmund	939
Edred	946
Edwy	955
Edgar	959
Edward II	975
Aethelred II	978
Edmund Ironside	1016
Danish Kings	
Cnut	1016
Harold I	1035
Hardicnut	1040
Restoration of Saxon Kings	
Edward the Confessor	1042
Harold II	1066
Norman Kings	
William I	1066
William II	1087
Henry I	1100
Stephen	1135
Plantagenet Kings	
Henry II	1154
Richard I	1189
John	1199
Henry III	1216
Edward I	1272
Edward II	1307
Edward III	1327
Richard II	1377

House of Lancaster	A.D.
Henry IV	1399
Henry V	1413
Henry VI	1422-1461
	1470-1471
House of York	
Edward IV	1461-1470
	1471-1483
Edward V	1483
Richard III	1483
House of Tudor	
Henry VII	1485
Henry VIII	1509
Edward VI	1547
Mary	1553
Elizabeth I	1558
House of Stuart	
James I	1603
Charles I	1625
Stuart Restoration	
Charles II	1660
James II	1685
William III and Mary II	1689
Anne	1702
House of Hanover	
George I	1714
George II	1727
George III	1760
George IV	1820
William IV	1830
Victoria	1837
Edward VII	1901
House of Windsor	
George V	1910
Edward VIII	1936
George VI	1936
Elizabeth II	1952



nexed by France in 1793 but became independent again in 1815.

Monarchy Until the late 1700's, almost all countries were ruled by monarchs, with titles such as *emperor*, *king* or *sultan*. Monarchs usually inherited their title and thrones from their fathers or other royal relatives. In some countries, daughters could inherit thrones as empresses, queens or tsarinas. But other countries, particularly the old kingdoms of Germany, banned women monarchs.

When the Romans began to occupy England about 1,900 years ago, they found it divided into many areas each with its own monarch. Not until the tenth century did one king claim to rule all England.

The first really strong king of England was William I, who conquered the country and founded the powerful Norman dynasty in 1066. Henry VIII joined Wales to England in 1536. King James VI of Scotland inherited the crown of England in 1603, and in 1707, England, Wales and Scotland became one country—Great Britain.

In 1714, a German king came to the British throne as George I. He understood very little English, and as a result, much of the power previously exercised by British monarches passed to the prime minister. This trend has continued.

Outside Britain, monarchy began to decline in the 1790's, when France became a *republic*—a country ruled by a president. Many monarchies collapsed as a result of the two world wars which began in 1914 and 1939. Republics replaced them. Republican governments were regarded as more democratic than monarchies, because presidents were usually elected.

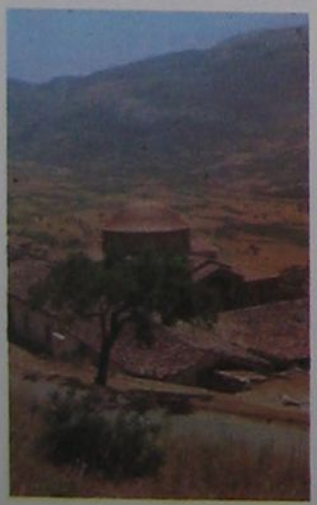
Most countries that have not become republics are now *constitutional monarchies*, where the real power is held by governments chosen from elected parliaments. They include Belgium, Britain, Denmark, The Netherlands, Norway and Sweden. Other important monarchies include Ethiopia, Iran (Persia), Japan, Jordan, Morocco, Saudi Arabia and Thai-

land (Siam) and several countries of the Commonwealth whose monarch is also the monarch of Britain.

Monasteries are places in which monks live in a religious community governed by strict rules of conduct. Monasteries play an important part in Christianity, Buddhism, and Jainism. In Burma and Thailand many young men become monks for at least a short time and then go back to their normal jobs. But many Christian monasteries are closed communities in which the monks have little contact with the outside world or indeed, in some cases, with each other.

Most religious orders lay down strict rules. Buddhist monks observe more than two hundred rules. Among them are rules that monks may not take life, steal, eat or drink too much, sleep in luxury, or possess gold and silver. Most Christian orders have three main rules known as the Counsels of Perfection. The monks vow to live in obedience, poverty, and chastity. They spend the day in prayer and work either in the monastery or outside it.

A view of the high altar in the Benedictine monastery of Fischingen, in Switzerland.



Whether situated in isolation or otherwise, monasteries tend to be more or less self-sufficient communities. The word monastery comes from Greek, and means 'living alone'.
Above: The Monastery of the Cross, Israel.
Left: The Monastery of Hosias Loukas in Greece.

Most monasteries depend on the gifts of religious people. Some monks actually beg for food and money. Many Buddhist monks go round with begging bowls. The Christian Dominicans and Franciscans are also *mendicant* (begging) orders. But most monasteries support themselves to some extent by selling farm produce, wine, perfume, or carvings in addition to general souvenirs.

Christian monastic life probably originated in Egypt in the 200's, when St Anthony brought together a number of hermits into a community with definite rules. In 320 the monk St Pachomius founded the first monastery. In the 360's St Basil of Cappadocia laid down rules that were accepted by many communities. Monastic life has changed little in the Eastern Christian Church. Its centre is

The monastic orders suffered a decline in the late Middle Ages. Monks became more worldly and in some cases even got married. The monastries became great landlords and abbots became powerful and rich. This led to the dissolution of the monastries in England. Similar suppressions happened in Austria and France during the 1700's.

the group of monasteries at Mount Athos in Greece. No female—human or animal—is allowed there.

Monasteries in the Western Church developed from the ideas of St Benedict, who in the 500's organized monasteries on a system of work, worship, and sleep. In England King Henry VIII abolished most of the monasteries in the 1500's.

Money At one time, when people wanted to buy anything they had to give something else in exchange for it. For example, if a farmer wanted to buy bread from a baker, he offered him eggs in exchange. The baker would accept them because he needed eggs. At this period, a person's 'money' consisted of the goods that he possessed or could produce. As communities became larger and trade developed, this method of buying, called *barter*, appeared to be a clumsy way of carrying on buying and selling. Some people then had the idea of using token goods for trade, things that all people considered precious and would accept. In many parts of the world, cattle were used as token goods or *money*. Today, in parts of Africa, they are still considered as the only real wealth. The English word *pecuniary* (consisting of money) comes from the Latin word *pecus*, meaning *cattle*.

Ancient Greek Coins

Above: A coin of the time of Mithridates. Left: A coin of the reign of Alexander the Great. The custom of showing a likeness of a ruler on the obverse (front) of a coin has continued to the present day.

The first people who are known to have used coins as money were the Lydians, who lived in Asia Minor. They began using stamped pieces of metal as a medium of exchange (that is, for buying and selling) as early as the 7th century B.C. But it is believed that the Chinese may have made coins at an even earlier date than that. The early coins were of irregular shapes and were stamped with rough designs. At one period of history, the Chinese shaped each coin into the form of the article it would buy. For example, the coins used for buying clothes were shaped like the human body.

Until recent times, the money value of coins (the amount coins were worth when used as money) depended on the value of the metal that the coins were made of. But today most countries use only *token coins*. This means that the value stamped on a coin is not the same as the value of the metal in the coin.

The economic troubles that followed the First World War led to many changes

Sometimes the designs on coins are emblematic. The figure of Britannia has in the past traditionally appeared on various British coins.

in people's thinking about money. Governments came to accept that there was no need for coins to be valuable in themselves. All that mattered was their value as money. Most governments began to issue token coins. Almost all the coins that are in circulation today are token coins. Their value as money is not related to the value of the metal of which they are made. People accept a coin in payment not because they value the coin itself but because they have confidence in the authority that issued the coin. Because coins are heavy and bulky, they are chiefly used for making only small payments. Larger payments are made in paper money which is issued by banks authorized to do so by a government.

As banking developed, many people found it more convenient to put their currency (coins and paper money) in a bank. They could then make payments or receive payments by means of cheques, and could leave in the bank for safe keeping any money that they did not need immediately. Today, very many people in most countries of the world use the services of a bank in this way. (See Banking.)

Governments control and regulate the use of money. A country's government decides what the basic unit of currency in the country will be. It decides what paper money shall be made and circulated, and what kind and value of coins shall be in use. The nominal value of a coin or piece of paper money (the value stamped or printed on it) is relative to its *purchasing power*. The real value depends on the amount of goods the coin or note will buy. During times of *inflation*, the real value of money goes down, because it will purchase fewer goods.

Talking points

* It is often said that 'money is the root of all evil'. What is meant by this? Do you think that it is true?
*Inflation is a major world problem. Money is losing value and increasing amounts are needed to buy articles. Can you think of any solution to the problem?
* At one time all money was in the form of metal coins. Try to discover how bank notes came into being.

Articles to read

Banking; Gold; Silver.

Top: The modern tendency is for paper money to become smaller and less ornate than in the past. But these Russian banknotes were used when Russia was still ruled by a tsar.
Above: Two examples of modern coin design.
Left: A pattern Gold Coin of the reign of Charles I.
Below: Inflation in Germany at the end of the First World War was so great that banknotes were printed for vast sums. This one is for 2 million marks.

Until recently the life of many people in Mongolia differed little from that of their fierce ancestors.

Mongolia is a Communist country in east-central Asia. It borders on the Soviet Union and China. The country's full name is the *Mongolian People's Republic.* Its capital is Ulan Bator. Mongolia was formerly called *Outer Mongolia.* A neighbouring territory, formerly called *Inner Mongolia,* belongs to China.

Mongolia has an area of 592,665 square miles. It is mainly a plateau, ranging from less than 2,000 to 14,000 feet above sea level. The vast Gobi Desert covers much of the country. It is bleak and stony. Mongolia has deposits of minerals, including gold, copper, iron and coal.

Mongolia is a very thinly populated country. It has only 1,240,000 inhabitants. The people live mainly by herding camels, goats, sheep, cattle and horses. The government has established state-owned farms on which the people live. Formerly they wandered from place to place. Mongolia has very little developed industry.

This location map shows the position of Mongolia.

The Mongols were tribal people who banded together in the 1200's under a great leader named Genghis Khan. Under him the Mongol Empire conquered most of Asia. But the empire did not last long. After it fell, Mongolia was along with China, controlled by the Manchus. In 1946 Mongolia gained independence from China.

Mongolia's climate is harsh, particularly in the Gobi; in winter temperatures drop to −20 °F and in summer rise to 115 °F. The daily temperature range is also great.

Mongols The greatest nomad attack on civilization was made by the Mongols. In 1206 a Mongol, Temujin, was chosen as Khakhan, or great ruler, at a tribal meeting at Karakorum, near Lake Baikal in Siberia. He took the name Chinghis or Genghis (the strong) and ordered his followers to conquer the world. By his death in 1227, the Mongols ruled from the Volga river to the north China coast. They were deadly fighters from horseback. With the invention of the bridle and the stirrup, they could use lances and shoot bows when riding. The Mongols killed the peoples they conquered in terrible massacres. They saved and gave power to merchants, artisans and scholars.

Ogodai, Genghis's third son, became Khakhan and began the conquest of China. To Batu, son of Genghis Khan's eldest son, had been left the conquest of Europe. This began in 1236 with the help of Subatai, the Mongol cavalry general. In 1240-2 Batu swept through western Russia, Poland, Czechoslovakia and Hungary, defeating all he met. Slav civilization was devastated. When they heard of Ogodai's death the Mongols left Europe to take part in the election of the new Khakhan. Hulagu, another grandson, conquered Arabia and attacked Egypt in 1255-8. His victories and massacres did enormous damage to Muslim civilization.

Mangu, the fourth Khakhan, and his brother Kublai conquered southern China

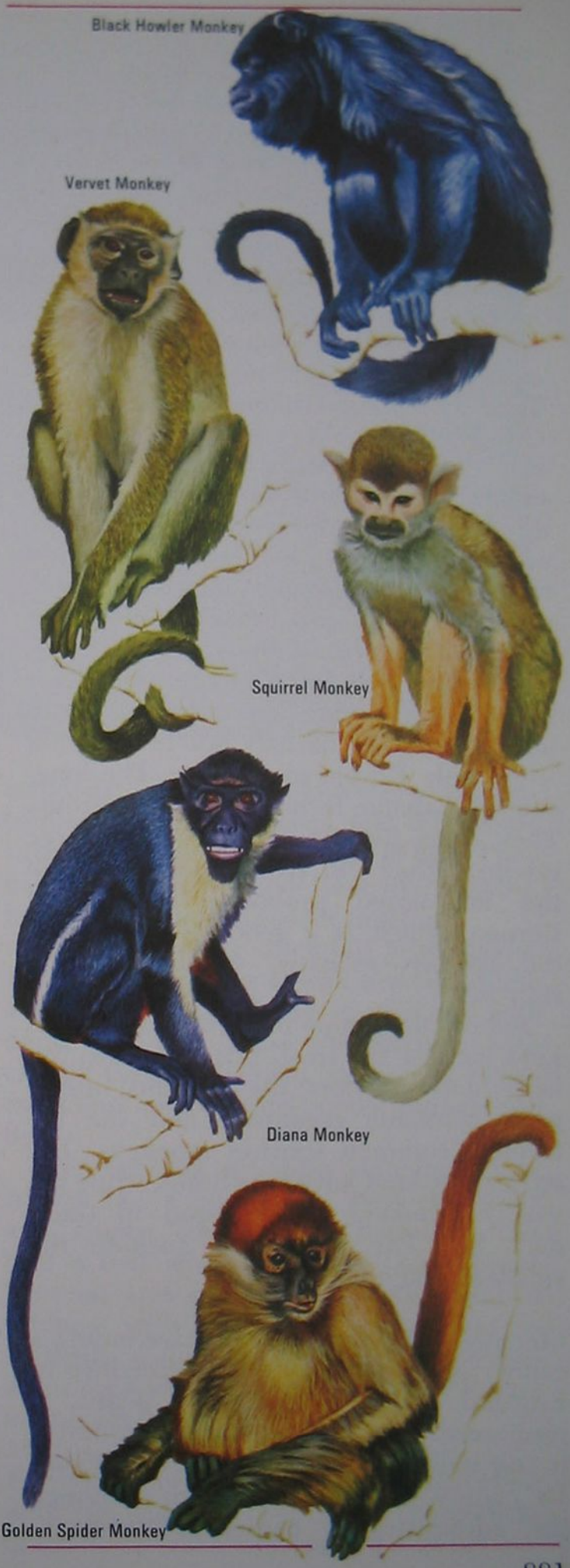
An Egyptian Mongoose.

in 1257-9. In 1259 Kublai succeeded Mangu as Khakhan and also became Emperor of China. The Mongols had ceased to be nomads. Under Kublai Khan there was peace and order over the whole area between Europe and China; trade in silk flourished. Europe and Asia were brought into contact. (See Nomads; China; Great Wall of China; Turks; Marco Polo.)

Mongoose This is a small flesh-eating animal related to the civet. There are many species (kinds) of mongooses, all of them natives of Africa or the southern half of Asia. They grow to about 1½ feet in length. They have bushy, tapered tails, and long bristly hair.

Mongooses kill and eat mice, rats, poultry, and other small animals. They are very fond of birds' eggs. They pick these up and throw them down to break them before eating the contents. But mongooses are best known for their ability to kill dangerous poisonous snakes, such as cobras. Their great speed enables them to do this.

Monkeys are furry animals related to the apes (see Apes). Most monkeys are smaller than apes and, unlike apes, generally have long tails. Their arms are shorter in proportion to their legs than are those of apes. Monkeys are less intelligent than apes, but have highly developed brains compared with other animals. They are clever with their hands and feet, and can grasp and hold objects.



Most monkeys live in trees, and are agile at running and leaping through the forests, many feet above the ground. All monkeys but the douroucouli of South America rest at night and are active during the day. The main food of monkeys is fruit and other plant food, insects and other small creatures, and birds' eggs.

Biologists divide monkeys into two major groups. They are the *Old World monkeys* of Africa, Asia and the south-western tip of Europe, and the *New World monkeys* of Central and South America. They show some striking differences. The Old World monkeys have longer noses, and eyes and nostrils that are closer together. They include a number of ground-dwelling kinds. All New World monkeys, on the other hand, live in trees. Many of them have *prehensile* tails—tails with which they can grip branches and swing along. No Old World monkeys can do this.

The macaques form a large Old World group. They include the common rhesus monkey and the barbary ape of Gibraltar—the only European monkey. The long-snouted baboons form another large group. They often live on the ground in large groups. Other Old World species include the long-nosed proboscis monkey of Borneo, which is a good swimmer, and the colobus monkey, which has long silky fur.

Important groups of New World monkeys include the small titis and sakis; the large, noisy howlers; the capucins, intelligent, acrobatic creatures; and the extremely common squirrel monkeys. The spider monkeys have long limbs, while the woolly monkeys are covered in thick, dark fur. The marmosets include the smallest of all monkeys.

Monmouthshire (area 541 square miles), a county lying between Gloucestershire in England and Glamorgan in Wales, is traditionally part of England. But today, it is culturally and politically part of Wales. Its county town is Monmouth (although the administrative centre is Newport).

The town of Caerleon-on-Usk in Monmouthshire is on the site of the Roman town of Isca Silurum. This was one of the major Roman military stations in Britain. It is one place where the legendary King Arthur is supposed to have had his capital city.

Monmouthshire's population is 461,500.

Most of the county is hilly, especially in the west. The chief rivers are the Wye, Usk, Ebbw, Rhymney and Monnow. Coalmining with its associated industries, such as iron and steel works, is the major occupation. The coal is found in the upland valleys of the north-western region, which forms part of the South Wales coalfield. Because this area suffered severely in the depression of the 1930's, a number of light industries were started to absorb some of the many unemployed workers. Among the newer industries were large nylon and plate glass works. Sheep are raised on the uplands, and farmers grow wheat, oats and barley. There are also many orchards.

The largest town is Newport. Other industrial centres are Abertillery, Ebbw Vale and Pontypool. Caerleon is built on the site of a Roman garrison town.

Monoliths are ancient statues, monuments or columns, each formed from a single huge block of stone. They may be *hewn* (cut) or unhewn, but have been placed in an upright position by man. Monoliths may be *menhir, obelisks* or single gigantic statues.

Menhir are prehistoric, rough, unhewn pillar stones, sunk in an earth base. They usually taper towards the top. The word *menhir* is Breton in origin, meaning 'long stone'. Many thousands of menhir have been discovered all over the world. There are more than 6,000 in France alone, where Carnac is an important site. Sometimes large menhir stand in a circle surrounded by an outer ring of smaller stones. Some of the stones that make up Stonehenge, on Salisbury Plain, are menhir. Their function may have been religious or commemorative.

Long rows of standing stones or monoliths at Carnac in Brittany, in north-western France. There are over 6,000 stones, and no one knows why they were put up.

Obelisks are huge, four-sided, tapering shafts of stone finishing in a pointed or pyramid-shaped top. They are of ancient Egyptian origin, and some date back to as early as 2900 BC. They flanked the entrances of the temples in pairs, in honour of the sun-god Ra. The two best known obelisks are the so-called Cleopatra's Needles, which weigh nearly 200 tons each and are about 70 feet high. One stands in New York's Central Park, and the other on the Victoria Embankment in London.

Among monolithic statues, the most famous and mysterious are those on Easter Island, in the South Pacific. More than 600 statues, 30 to 40 feet tall, are scattered across the island on raised temple platforms. They are believed to be the work of Neolithic peoples.

Monotremes make up an order of primitive, egg-laying mammals found only in Australia and New Guinea. They are represented by two groups—platypuses and echidnas, or spiny anteaters. Monotremes have hairy bodies, and the babies suck milk directly from tufts of hair. They have no teeth in their beak-like mouths, but possess sharp claws for digging.

The platypus or duck-bill grows about 2 feet long, and has a beak somewhat like a duck's bill. Its body is covered with dense fur, and it has webbed feet with clawed toes. Platypuses are expert swimmers and feed on small water animals and fish.

The echidna or spiny anteater looks rather like a porcupine, with stiff hairs and spines covering its body. It rolls into a ball when alarmed. The echidna lives on ants and other insects, which it catches with its long, sticky tongue. It feeds mainly at night. Its short legs are armed with clawed feet, which it uses mainly for burrowing.

Monsoons are winds that change direction with the seasons. They affect the climate of southern and south-eastern Asia in part-

Monsoon circulation over the Indian Ocean. Between April and October moisture-laden wind blows from the ocean (top). In winter the wind changes direction and blows from land to sea (above).

icular, but also occur in northern Australia and on the Gulf coast of the United States.

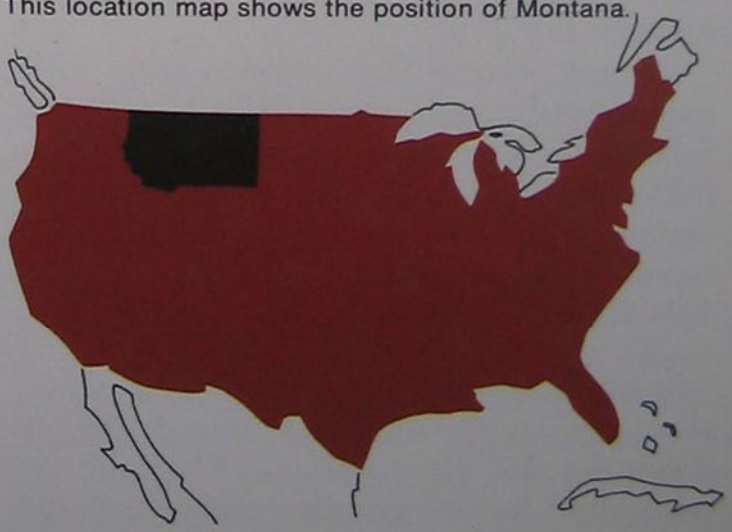
In continental areas, such as India, the monsoons bring distinct wet and dry seasons. The rains come during the summer months, when the wind blows from the ocean towards the land, bringing moisture with it. In winter the wind blows from the land towards the ocean and brings no rain. In Indonesia, Malaysia and other places more or less surrounded by water, the monsoons bring rain whichever way they blow because they always come from the ocean. Monsoon rains vary greatly from year to year, for unknown reasons. During the times when the monsoons change direction, tropical storms are likely to occur.

Monsoons are at least partly explained by temperature differences between the major land and sea masses. The land changes temperature more rapidly than the sea, so it is hotter in summer and colder in winter. Winds tend to blow from cool to warm areas, so in summer they move towards the land.

Montana is a large and sparsely populated state of the United States, bordering Canada. In western Montana are the high Rocky Mountains; eastward the land becomes a grassy plain. Almost half of Montana's 694,000 people live in rural areas. Only Helena, the capital, and two other cities have more than 25,000 inhabitants. About 30,000 Indians live on reservations. Montana is rich in minerals and was once a gold-mining area. Oil, copper, natural gas and lumber are leading products. Ranching is the main agricultural activity. Montana was originally settled by American fur trappers. The United States acquired most of Montana from France through the Louisiana Purchase of 1803. White settlers defeated the native Indians in a series of wars that lasted from 1867 to 1877; although the Sioux Indians won a victory at the Battle of the Little Bighorn, scene of General Custer's famous 'Last stand'. Montana became a state in 1889.

Montcalm, Louis Joseph de (1712-1759), was a French general who went to Canada to fight for the French-Canadians in the

This location map shows the position of Montana.



Seven Years War against Britain. He lost his life defending the city of Quebec.

During earlier battles of the war, Montcalm captured important forts at Oswego and Lake George, and successfully defended Fort Ticonderoga. In 1759, he and his men, after repelling the British once at Quebec, again faced them on the Plains of Abraham. The French were defeated by the British under General James Wolfe. He too was killed in the battle.

Montgomeryshire (area 797 square miles) is an inland county of central Wales. Its county town is Montgomery and its population is 43,300.

The county consists mainly of bleak, mountainous moorland, rising to nearly 3,000 feet in the Berwyn Mountains in the north. The chief rivers are the Severn, Vyrnwy, Dovey and Wye. Sheep are grazed in the uplands, and there are important dairy farms in the fertile plains to the east of the county, where oats is the main crop. Slate, stone and lead are quarried. Welshpool is the main town after Montgomery.

Months are periods of time into which the year is divided. These can be calculated in different ways. The system we use is based on the *solar*, or Sun, year of 365 days. We divide the year into 12 months, some of 30 and some of 31 days' duration—except for February, which has only 28 days (or 29 days during a leap year).

Our system and the names we use for the months come originally from the old Roman calendar. January, for example, is named after the Roman god Janus, March after the god Mars, and September, October, November and December come from the Latin form of the numbers seven, eight, nine and ten. The Roman calendar at first had only 10 months (March to December). January and February were added later.

Julius Caesar gave the calendar much of its modern form. He renamed July after himself. In his day, the dates within the month were not numbered, but instead were calculated from three points called the Kalends, Nones and Ides. The final revision of the calendar, giving it its present form, was made by Pope Gregory in 1582—hence its name of *Gregorian Calendar*.

The other basic way in which months are calculated is by the Moon. The *lunar month* is usually taken from new moon to new moon, which gives months of 29½ days, and a year of 354 to 355 days. The Muslim calendar uses this system. But because the lunar year does not correspond to the solar year, the months do not fall in set seasons. In order to overcome this problem, other systems, such as that used in the Jewish calendar, add an extra month every three years or so to keep the months and seasons aligned.

Montreal is the largest city in Quebec province, Canada, with a population of 1,466,000. It occupies a commanding position at the confluence of the St Lawrence and Ottawa rivers. Ville-Marie, a small settlement of 1642, became a base for traders and explorers. Incorporated as a city in 1832, it has developed into one of the world's most important ports

The centre of Montreal with the St Lawrence in the background.

and a chief commercial and industrial centre of Canada. It is also a leading educational and cultural centre. The port is a hub of the network of ocean and lake traffic through the St Lawrence Seaway which has its entrance in the harbour.

Moon As the Earth travels round the Sun, it is accompanied by its nearest neighbour in space, the Moon. The Moon is called the Earth's *satellite*, and revolves around the Earth in a definite, regular path called the Moon's *orbit*.

The Moon is held in its orbit by the *gravitational attraction* of the Earth. This was first explained by the great scientist Sir Isaac Newton (1642-1727). He knew that every object attracted every other object. He explained how this force of attraction (the *force of gravity*) keeps the planets revolving in their orbits around the Sun and the Moon in its orbit around the Earth.

The Moon is about a quarter the size of the Earth in diameter, and its weight is about one-eightieth that of the Earth. Astronomers know a great deal about the Moon. It is bleak, and has no air or water. It has a hard surface, partly covered with dust and pitted with craters. It has great, dry plains, known as *maria*, or *seas*, and towering, jagged mountains. On the Moon, days are extremely hot and nights extremely cold.

Our knowledge of the Moon has been greatly increased in recent years by the advent of space travel. On 20th July 1969, Neil Armstrong, the commander of the American Apollo 11 space mission, became the first man to set foot on the Moon. Since then, the United States has made five more manned landings. Because of the very high cost of putting men on the Moon, it seems likely that the Apollo 17 mission that took place in December 1972 was the last for some time to come. Samples of rock brought back by the astronauts have enabled scientists to make discoveries about the composition and origin of the Moon. The USSR have not sent men to the Moon, but in November 1970, they landed a remote control vehicle called Lunokhod 1. This made a journey of over six miles on the Lunar surface and continued to send back information about conditions on the Moon until October 1971. In January 1973, the Russians landed a second Lunokhod on the Moon.

The Moon's orbit round the Earth is not quite circular. It is *elliptical* (oval). As a result, the Moon is nearer the Earth at some times than it is at others. When the Moon is near the Earth, it travels faster along its orbit than when it is farther away. Its average speed is about 2,300 miles an hour.

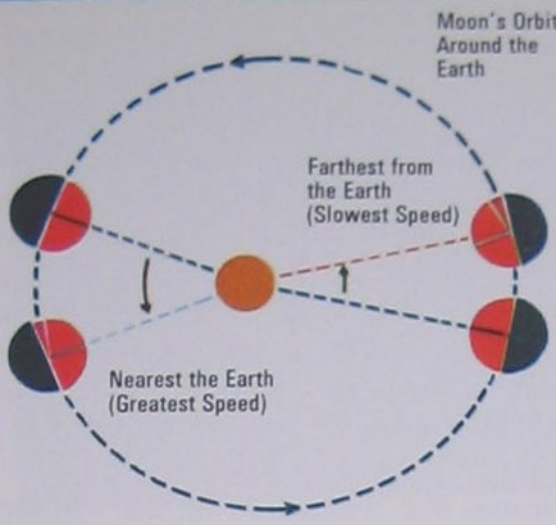
The average distance of the Moon from the Earth is about 239,000 miles. In space, this is a short distance. A rocket that took a day to travel from the Earth to the Moon, would take a year to reach the Sun, travelling at the same speed.

Because the Moon is near the Earth, it appears to us to be much bigger than the stars. In fact, the stars and all the planets are bigger than the Moon, some of them millions of times bigger.

The Moon takes 27 days and 8 hours to travel round the Earth. It also takes exactly the same time to rotate once upon its own axis. As a result, the same part of the Moon's surface is always turned towards the Earth, and until recently men had only ever seen this part of it. Our first knowledge of what the other side of the Moon looks like came in 1959 when the Russian space-probe Lunik 3 circled the Moon and transmitted photographs of the hidden side back to Earth. The far side of the Moon seems to have similar features to the side whose surface we have been able to study in detail.

The Moon has no light of its own. The silvery moonlight which has inspired poets, painters, and musicians, is really light from the Sun which is reflected by the Moon's surface.

As the Moon moves round the Earth, different portions of its surface receive the sunlight. This causes it to appear to



Owing to its slight wobbling movement it is possible to see around alternate 'edges' of the Moon.

The side of the Moon which faces the Earth.

This picture of the far side of the Moon is based on photographs taken by the Russian automatic interplanetary station, Lunik 3.

This bronze family group was sculpted by Henry Moore in 1949.

us almost as though the Moon changes its shape as the month goes on. We call these 'changes' the *phases* of the Moon. The phases range from New Moon (when the Moon is not visible at all), through First Quarter (half illuminated) to Full Moon (whole disc illuminated). From Full Moon the sunlit part of the disc turned towards us gradually shrinks, through Last Quarter (half illuminated) to New Moon again.

The craters or ring formations on the Moon's surface range from vast mountain-encircled plains, up to 150 miles across, to tiny pits only two or three feet across.

The largest craters can be seen with good binoculars, but the smallest crater pits can be detected only on the photographs transmitted back to Earth by space probes.

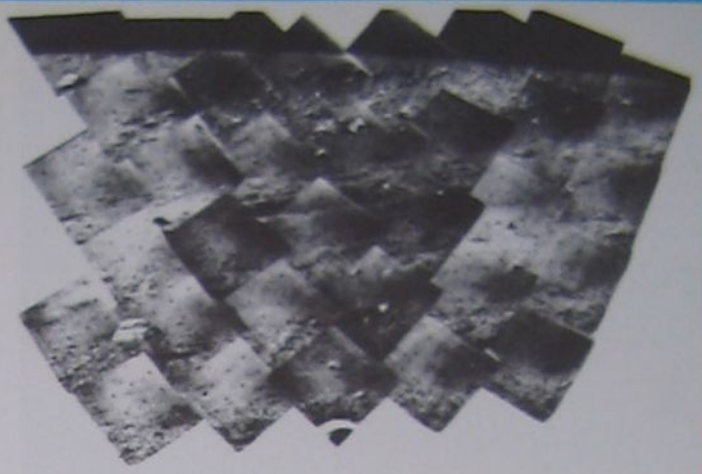
Some of the craters have bright streaks radiating from them called *ray systems*. These can be seen most easily at Full Moon. Astronomers do not know what causes them.

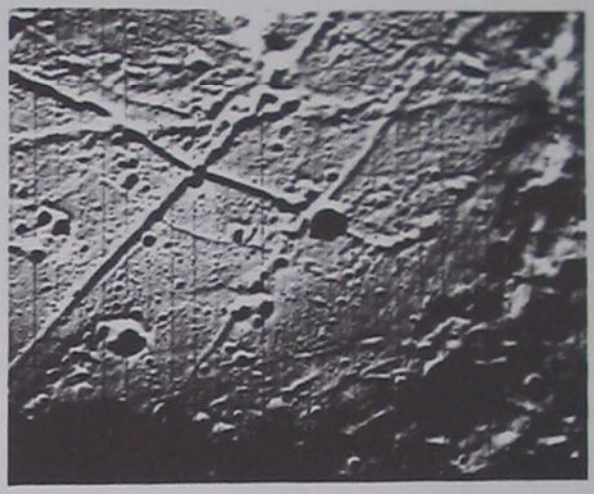
Moore, Henry (1898-), a British sculptor, is considered to be one of the greatest sculptors of the 20th century. He was born in Castleford, and studied art in Leeds and London. His first one-man show took place in 1928. Since then, his work has been widely exhibited. Moore created works for important buildings in Paris, New York, Chicago and London. Moore's sculptures are massive pieces, usually done in bronze or stone. A favourite theme is mother and child.

Mormons are members of the Church of Jesus Christ of Latter Day Saints. Mormons believe in the Bible, and the main teachings of the Christian religion. But they have added a number of original beliefs of their own. The church has its headquarters in Salt Lake City, Utah, in the United States. The mormon temple and tabernacle are two landmarks of the city. The Mormon Tabernacle Choir is known throughout the world for its fine recordings of hymns and choral works. Most of the more than 2,500,000 Mormons live in the western United States. But the Mormons send many young men and women as missionaries to other countries.

Joseph Smith founded the Mormon Church in 1830. He claimed to have been divinely led to certain buried golden plates. These were inscribed in a strange language. He translated them into the *Book of Mormon*, a record of early inhabitants of America. Smith and his disciples soon began to look for a home. They settled first in Missouri, but were persecuted and driven out. Then they went to Illinois, where, in 1844, Smith and his brother were murdered by a mob.

Brigham Young arose as the new leader of the Mormons. He led them to what is now Utah. There he founded Salt Lake City in 1847. Utah became a U.S. territory in 1850. But Congress would not grant statehood at first because the Mormons practised polygamy (had more than one wife at the same time). The Mormons eventually gave up this practice.



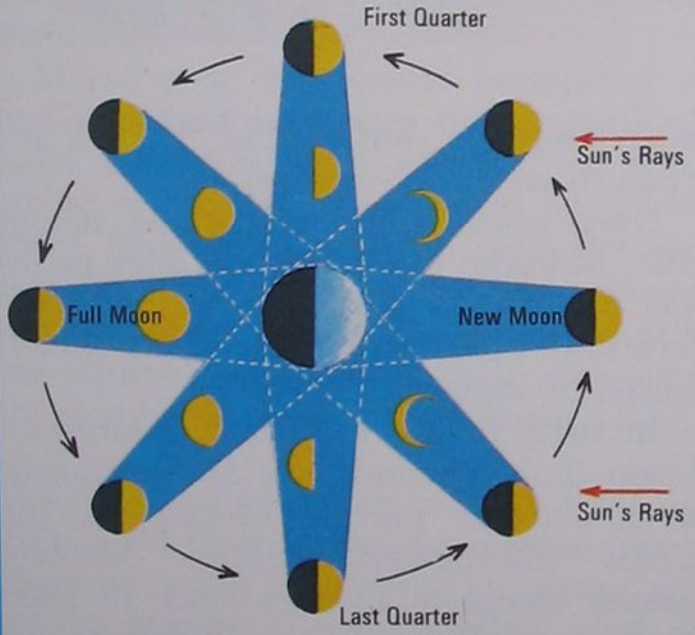


The Moon

Above left: A photograph of the crater Langrenus from the Apollo 8 spacecraft. This crater is 85 miles in diameter.

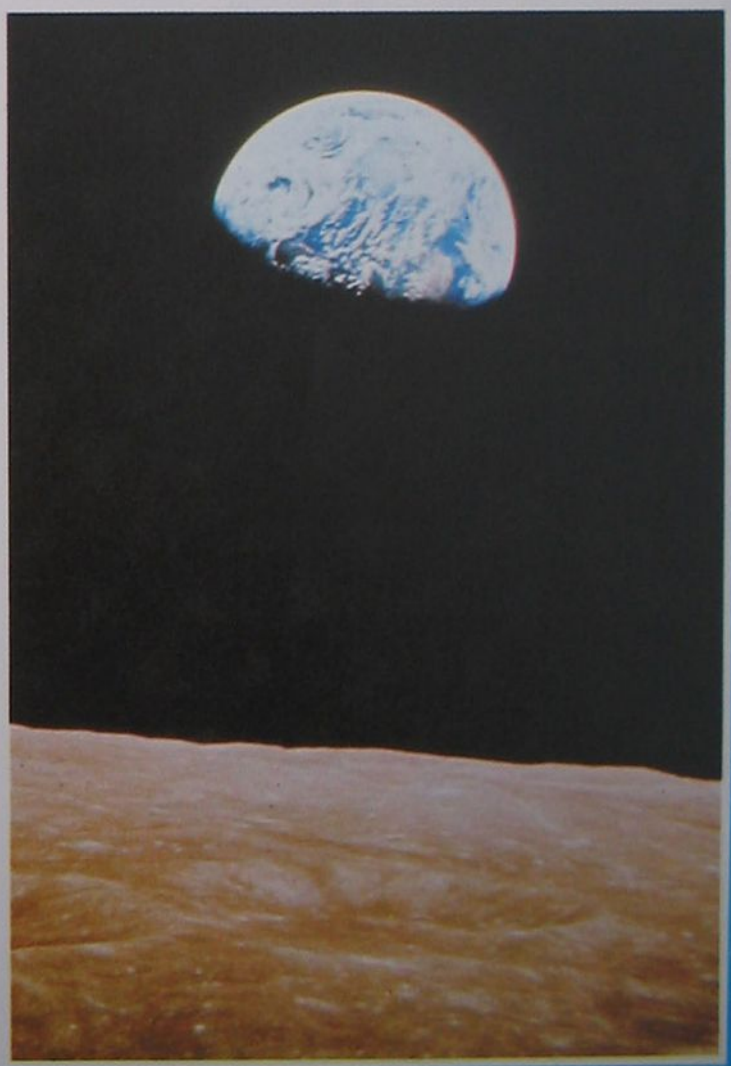
Above right: A mosaic of the lunar landscape built up from photographs taken by Surveyor 3 which landed in the Ocean of Storms.

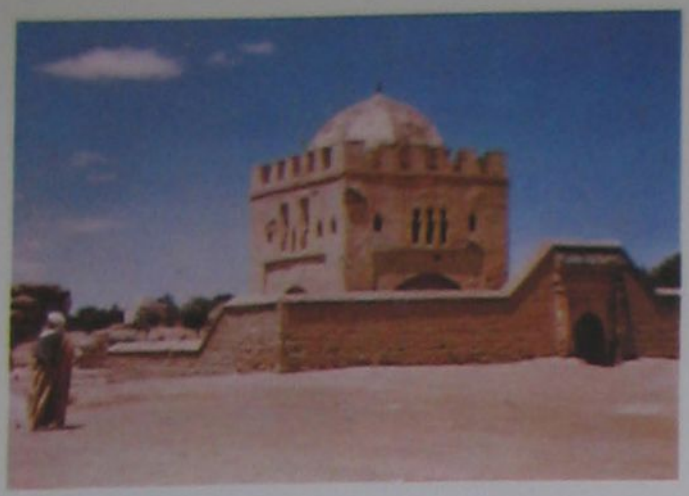
Right: The floor of the crater Hevelius, seen from Lunar Orbiter 3. This picture was taken from an altitude of about 36 miles.



Above: Phases of the Moon. We only see the part of the Moon which is illuminated by the Sun. When the Moon is between the Earth and the Sun none of the illuminated side can be seen from the Earth (new Moon). When the Moon is at the other side of the Earth the whole of the illuminated side can be seen (full Moon). Between these two positions we see part of the illuminated side.

Right: What the Earth looks like from the Moon. In the foreground is the Moon's barren surface. The surface of the Earth is obscured by a layer of cloud. This photograph was taken from Apollo 8.





Above: A Mosque in Marrakesh, the second largest city in Morocco.
Above right: Pottery merchants in Tangiers.
Left: Morocco is situated in the north-west corner of Africa.
Right: Berber women. Berbers make up about a quarter of the population of Morocco.

Morocco is a Muslim kingdom in the extreme north-west of Africa inhabited mostly by Arabs and Berbers. Many French, Spanish and Jewish people also live there.

The country has long, temperate Mediterranean and Atlantic coastlines. But the land merges southwards and eastwards into the barren Sahara desert. The snow-capped Atlas Mountains straddle the country from north-east to south-west. Several rivers flow through semi-desert areas, creating fertile valleys and oases where many farmers have settled.

Morocco has a pleasant climate which is less extreme than most other African countries. Rainfall is moderate, but sufficient to make much of the country suitable for crops or for pasture land. Most Moroccans are farmers.

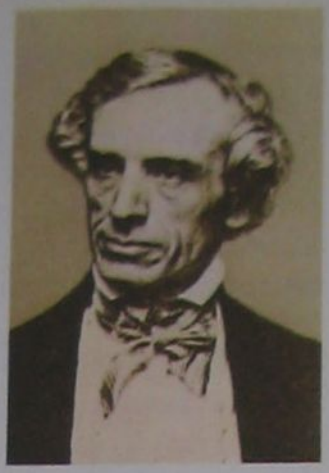
Many Moroccans still wear flowing robes as their ancestors did. And most Arab women wear the veil. Arabic is the main language, but Berber, French and Spanish are widely spoken.

Once under Carthaginian and Roman rule, Morocco fell to Arab armies in the A.D. 600's. From the 1300's to the 1800's, ferocious Moroccan pirates were widely feared by seaman.

In 1912, France took most of Morocco. Spain took the northern, Mediterranean strip, and the port of Tangier was put under international control. Morocco gained complete independence in 1956. At the end of 1968, Spain ceded its tiny colony of Ifni to Morocco.

Facts and Figures
Area: 171,413 square miles.
Population: 15,525,000.
Capital: Rabat.

Morse code is a method of sending messages by telegraph, by radio, or even by light signals. It consists of a series of dots and dashes to represent letters, numbers



A portrait of Samuel Morse from an early photograph by Louis Daguerre, inventor of the *daguerreotype* process.

and punctuation marks. Letters are represented by up to four dots and dashes. Numbers consist of five dots and dashes, and the punctuation marks are made up of six. One dot represents E and one dash T, the letters that occur most often in English. This is because Morse code was invented in 1840 by an English-speaker, Samuel Morse of the United States, who also invented the telegraph. But Morse code became an international code, used for telegraph and news messages around the world.

Morse code was useful because it is easier to send a message by telegraph or radio consisting only of short or long bursts of power, than to send an actual voice. Nowadays telegraph messages are sent by automatic teleprinting machines. But signalmen in the military services still use Morse code. Morse code messages are sent between ships by flashing a light.

Mosaic is a form of decoration built up from small pieces of coloured glass, stone, china, or other material. The pieces are set in cement. *Grout*, another kind of cement, is used to fill the cracks between them. Mosaic is used mostly on floors, walls, and table tops. It can easily be cleaned by washing, and is extremely hard wearing. Many mosaic floors made by Greeks and Romans nearly 2,000 years ago still exist. Mosaic is laid either in one colour or in a combination of colours forming a pattern. Many fine mosaics are laid in the form of pictures.

Moscow is the capital city of Russia. It is situated on the Moskva River in the European portion of the Russian Socialist Federal Soviet Republic (R.S.F.S.R.) the largest of the 15 constituent republics of the U.S.S.R. It was made the capital of the Soviet Union in 1918 when the seat of government was removed from Leningrad. With a population of 7,172,000, it is the largest city in Russia and the sixth largest city in the world. It is a picturesque city of many gilded domes, broad avenues and spacious squares.

Moscow is the country's political and administrative centre. The city is built on and around the site of the Kremlin, the ancient walled citadel or acropolis. The Kremlin is the seat of the highest state bodies of the Soviet Union, the Supreme Soviet (Parliament) and the Council of Ministers. Within the walls are palaces, cathedrals and offices. The Uspenski Cathedral was the crowning place of the tsars, and the Arkhangelski their place of burial.

A fine mosaic in the Basilica of San Vitale at Ravenna, Italy. It portrays Christ among the archangels.

The Church of St. Basil, in Moscow, stands on the south side of Red Square.

Red Square, beside the wall of the Kremlin, is nearly a quarter of a mile long. It is often the scene of military parades.

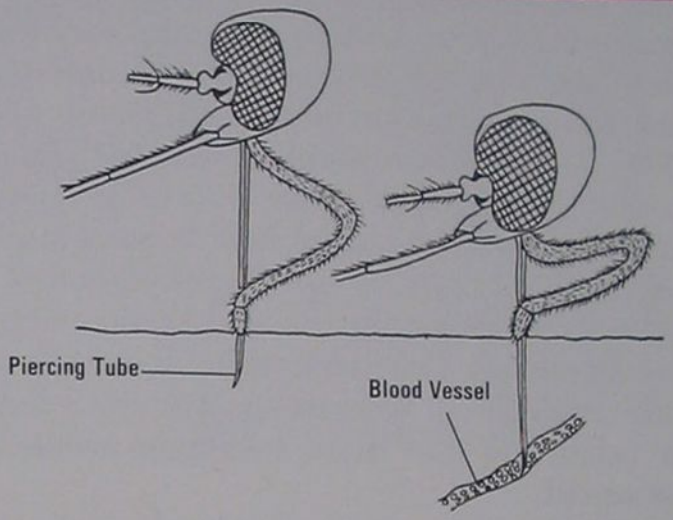
The city is the chief financial and business centre. It is a hub of rail and waterborne traffic with considerable European and Asiatic trade. As the major trading centre it has extensive steel and textile works and many factories producing cotton, wool, silk and leather goods.

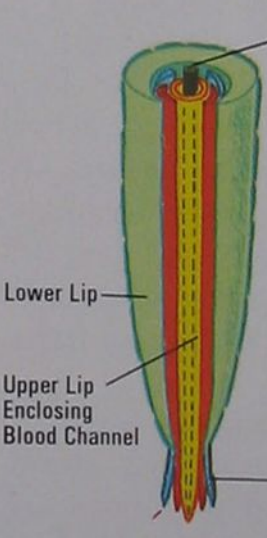
Moscow is a great seat of learning with many schools of varying grades. The Lomonosov University, the State University, on the Lenin Hills is the largest higher education establishment in Russia. The U.S.S.R. Academy of Sciences and many other academies provide specialized training.

The city is also a great cultural centre with large museums, public libraries, concert halls and drama theatres with rich and varied repertoires. In the world of music and drama, the fame of the Bolshoi Theatre and Ballet, the State Symphony Orchestra of the U.S.S.R., and the State Folk Dance Company is wide spread.

Moses was a great Jewish leader, teacher and lawgiver, who lived probably about the 14th century B.C. His story is told in the Old Testament of the Bible (*Exodus, Leviticus, Numbers* and *Deuteronomy*). Moses, under divine guidance, led the Israelites out of captivity in Egypt into the promised land of Canaan. He received the *Ten Commandments*, on Mt. Sinai, and so laid down the framework of the Jewish religion.

Mosquito The mosquito is a member of the fly family of insects. Mosquitoes are dangerous to man because they can spread diseases. The male mosquito is harmless.

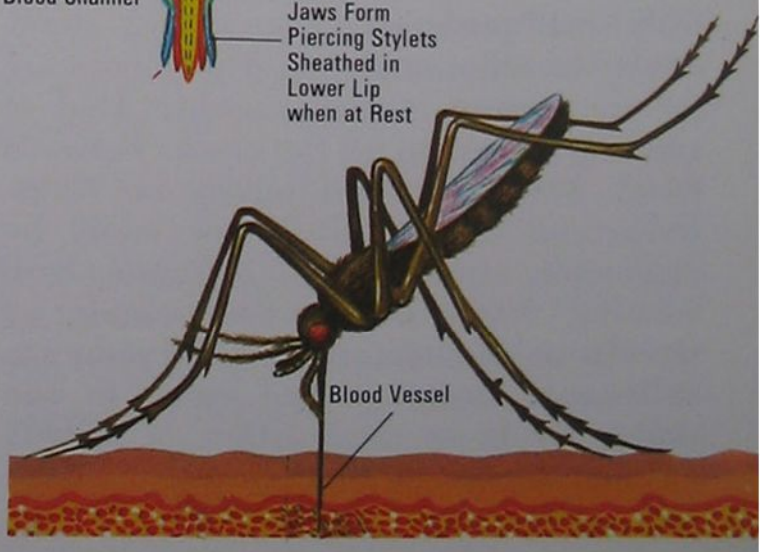




Above: A mosquito piercing the skin and a blood vessel in its host.

Left: A cross section of the mosquito's piercing tube. Blood is drawn up through a central canal.

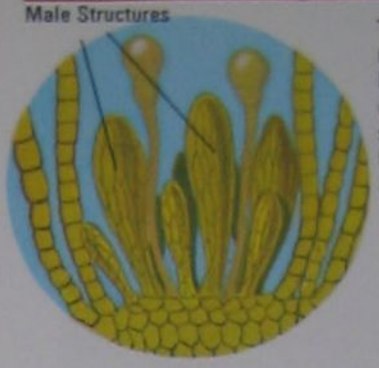
Below: A female mosquito sucking blood. The male is harmless.



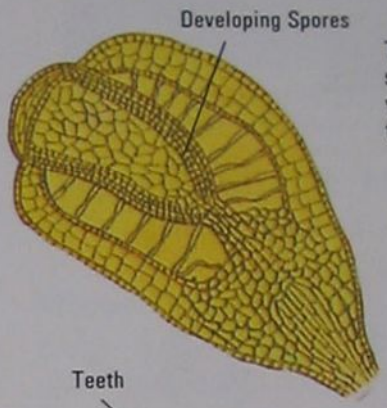
But the female mosquito feeds on the blood of animals or human beings. Her mouthparts have a piercing tube that sinks down through the skin into a blood vessel, enabling her to suck up blood. Sometimes she feeds on a diseased animal. When she next attacks an animal or a human being, she may pass on the disease. Certain kinds of mosquitoes spread malaria and yellow fever in this way in tropical areas.

Mosquitoes hatch from eggs laid on the surface of still water. The larvae hang just below the surface, breathing through two tiny air tubes at the end of their bodies. After one to five weeks, the larvae change into large comma-shaped pupae. About three days later, the pupae change into adult mosquitoes.

Mosquitoes can be controlled by spraying oil on the water in which they breed to prevent the larvae breathing; by putting special fish into the water to eat the larvae; or by spraying the adults with insecticides.



The moss *Funaria* is common on burnt ground. Male and female organs occur at the tips of separate branches. After fertilization the spore-capsules develop.



The spores develop inside the capsule, and when ripe are discharged through the opening.

A series of water-sensitive teeth control the opening of the capsule, so that spores are shed only in dry weather.

Mosses are leafy little plants that grow in shady places. Together with liverworts, mosses make up a division of simple plants that botanists call *Bryophyta*. There are roughly 15,000 kinds of mosses in the world. They have no economic value, but are of interest to biologists because the first land plants were probably of this type. In addition, mosses are valuable as soil builders, since they are among the first plants to colonize new land.

Mosses reproduce by means of *spores*. The spores are carried in a capsule borne on a long stalk which arises from the crown of a moss stem. The capsule commonly has a little lid, which falls off when the spores are ripe, and a ring (or two rings) of tiny teeth attached to the rim and pointing inwards. The teeth open or close according to the amount of moisture in the air. In dry air, the teeth are open and the spores are shaken out by the wind.

Moss spores germinate into a highly branched, green, threadlike body called a *protonema*. The protonema gives rise to several new moss plants in a small clump.

When the moss plants are mature, the tips of the stems and branches develop sex organs. Male cells are released in wet weather, and swim to the female cells and fertilize them. The fertilized female cell develops a long stalk bearing a spore capsule at its top.

Moths are insects related to, and closely resembling, butterflies. Butterflies and moths make up the order of insects called *Lepidoptera*, meaning 'scaly wings'. A moth can usually be distinguished from a butterfly by its antennae. Butterflies

The hummingbird hawk moth using its sucking tube to collect nectar.

Above: A clothes moth grub, showing typical damage to fabric. The grub, which is a little under half an inch long when fully grown, spends its life in a camouflaged silken shelter.

Below: An adult clothes moth. It is the larva and not the adult moth that causes damage to fabric.

always have a small knob on the end of their antennae, whereas moth antennae take many different shapes and seldom have knobbed ends. In addition, most moths fly by night whereas butterflies fly by day.

The life history of the moth is similar to that of the butterfly. The eggs are usually laid on plants that serve as food for the larvae, or caterpillars, that hatch from the eggs. The larvae change their skins and grow new ones several times as they get larger. When they are fully grown, they turn into hard-shelled pupae, or chrysalises, inside which the insects rest and change into adult moths. Some caterpillars spin a cocoon of silk around themselves before turning into pupae. The cocoon gives them extra protection. When pupation is complete, the adult moth emerges from the pupa. Its wings are soft and crumpled at first, but they soon fill out and harden. The moth also takes in air to 'blow up' its body.

An adult moth is like a butterfly in many ways. It feeds by extending a *proboscis* from its mouth into flowers to suck up nectar. The hummingbird hawk moth can hover an inch or so above a flower and extend its proboscis down into the flower.

Moths are found all over the world. They vary in size from about one-eighth of an inch to nearly one foot in wing-span. They may be striking in colour, such as the large green luna moth, or the red tiger moth. These bright colours often warn their enemies that they are unpleasant or even poisonous to eat. The luna moth has eye-spots—two markings on its wings resembling eyes—that tend to scare away enemies. But many moths are dull-coloured and this helps to hide them among their surroundings.

If you want to study moths, it is very easy to catch them, because they are attracted towards a bright light. Adult moths seldom live long in captivity, but caterpillars can be kept easily by feeding them on foliage.

A few moths are harmful to man. The

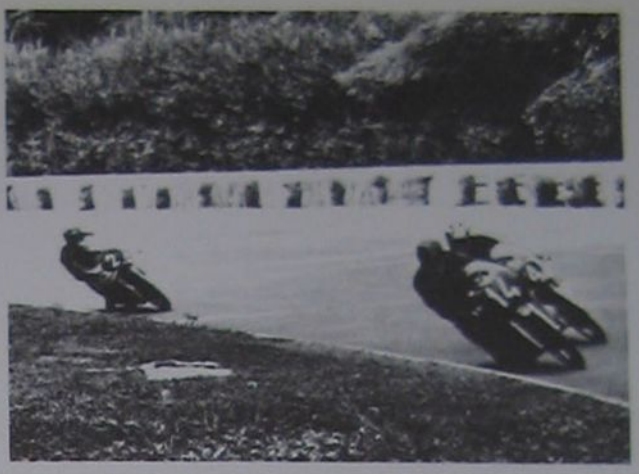
The Hercules emperor moth of Australia and New Guinea has a wing-span of up to ten and a half inches and is the largest moth in the world. This compares with the British moth Nepticula microtheriella, *which has a wing-span of just over a tenth of an inch and is the smallest.*

tent caterpillars of northern Africa strip trees for food, and many tussock moths attack trees. Moth caterpillars may also cause damage to crops such as wheat and fruits such as peaches and apples. The clothes moth lays its eggs in cloth and when the caterpillars hatch out they eat holes in the cloth. But moths are also useful to man. Silkworm moths' cocoons are used to make silk thread and cloth.

Motion is a term that describes movement in space. There are many different kinds of motion. *Linear motion* is motion in a straight line. *Curvilinear motion* is motion in a curved path. Motion can be forwards, backwards, or in any other direction. But it exists only in relation to some fixed point or observer.

Scientists use two different terms to describe the rate of motion. One of these is *speed*. Speed refers to the distance covered during a set period of time. The direction does not matter. *Velocity,* on the other hand, refers to the speed in a given direction.

The English physicist Sir Isaac Newton stated several important laws of motion. The first of these says that an object in motion will keep moving for ever at the same speed and in the same direction unless some outside force changes it.



Motor cycle racing at Monza, in Italy. There are important races in a large number of countries.

Often this outside force is friction. One form of friction is air resistance.

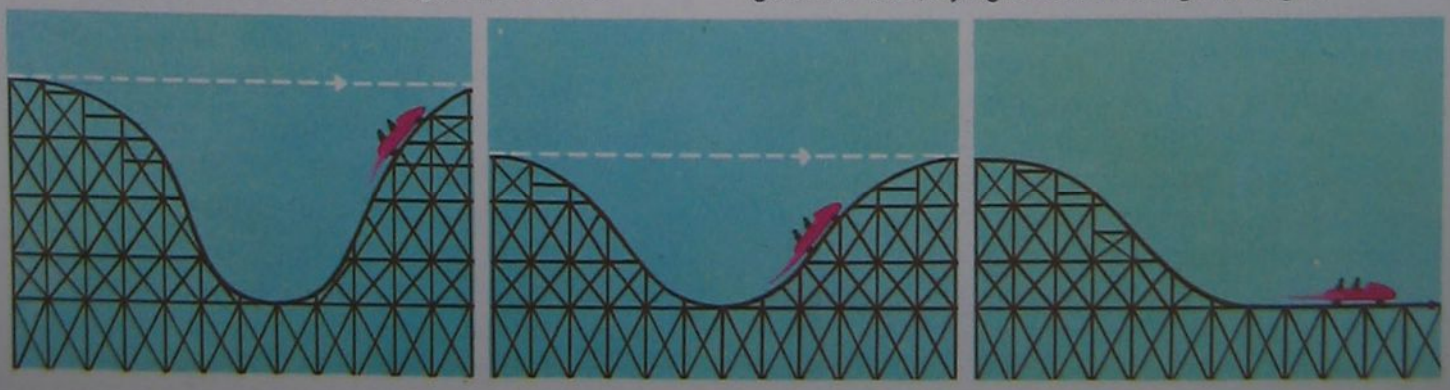
Motor cycle Gottlieb Daimler built not only one of the first automobiles but also the first motor cycle, in 1886. He fitted one of his petrol engines to a bicycle frame. But today's motor cycles are highly specialized machines.

The engine of a motor cycle is similar in many respects to that of an automobile, but much smaller. It, too, has either a two-stroke or a four-stroke engine with petrol as fuel. (See Automobile.) It may have one, two, three, or four cylinders, which are cooled by air or water.

The engine is started by kicking down a *kick-starter*. This turns the engine over and starts it firing. Some modern motor cycles have an electric self-starter, like a car. The speed of the engine is controlled from a *twist-grip* on the handlebars.

The gearbox is operated by a foot

An example of Newton's first law of motion. The car coasting downhill without friction would tend to climb the next slope until it reached a height equal to that from which it started. If the downhill slope were followed by a horizontal track (right) the car would go on for ever, trying to reach its original height.



In rally driving, competitors use public roads. This car is competing in the London to Sydney Marathon of 1968.

Grand Prix racing. The aerofoils mounted at the back of the cars serve to keep them firmly on the ground.

lever, and power is normally transmitted to the rear wheels by a chain drive though some larger motor cycles have a drive shaft. The clutch is operated by a hand lever on the handlebars. So is the front brake. A foot pedal operates the rear brake.

Motor sport Competition motoring embraces a variety of activities including speed record attempts, races for all types of cars from Grand Prix racers down to small open-framed karts, hill climbs and speed trials, and a combination of the latter on a mapped-out circuit which is an event called Autocross. It also includes rallies of all types.

The first automobile trial took place in 1894; a reliability run from Paris to Rouen, won at a speed of 11·6 mph. The first race took place a year later from Paris to Bordeaux and back.

Today motor sport is governed by the Federation Internationale de l'Automobile in Paris, which lays down dimensions and conditions for racing cars in various categories. Formula 1 (Grand Prix class) is for single-seater racing cars weighing a minimum of 500 kilos (1,102 lb) with engines not exceeding 3 litres capacity. Grand Prix races counting for the World Championship must be run over 300-400 kilometres (190-250 miles). Maximum speed of these Formula 1 cars is about 190 mph.

Formula 2 racing cars must weigh 429 kilos (925 lb), and use a 2 litre engine. Formula 3 is for cars weighing not less than 400 kilos (880 lb) with a 1·6 litre, 4-cylinder engine, and only one carburettor. In 1967 a new type of race known as Formula 5000 was introduced. This is for cars with engines of up to five litres. Although they have larger engines, Formula 5000 cars are not as fast as Formula 1 cars, being heavier and less manoeuverable.

Since 1950 Grand Prix drivers have contested a points-based World Championship of between 12 and 14 events throughout the world, the most successful being Juan-Manuel Fangio, who won 5 times from 1951-7. The most difficult Grand Prix circuit is probably Monaco, which runs round the streets and harbour of Monte Carlo, and has ten corners and several hills.

The most important race for sports cars is the 24-hour Le Mans Grand Prix d'Endurance first held 1923, won nine times by Ferrari cars from 1949-1965.

The first long rally was promoted in 1907 from Peking to Paris, a route about 7,500 miles in length. Now major rallies are often about 2,000 miles long and run over a difficult route.

Also made possible by the invention of the petrol engine, motor-cycle sport is closely linked. The first motor-cycle race was held from Paris to Dieppe in 1897.

Competitors and mechanics surround the cars just before the start of a race at Brands Hatch, England.

The oldest races still taking place are the Auto-Cycle Union Tourist Trophy series first held in the Isle of Man in 1907. The Senior (500 c.c.) T.T. held on the Mountain circuit is the fastest in the United Kingdom. In June 1967 Mike Hailwood, M.B.E. (born Oxford) won at an average speed of 105·618 mph on a 4-cylinder 500 c.c. Honda. Hailwood has won more world championship titles than any other rider, but the most successful machine has been the Italian M.V. Agusta which had won 271 World Championship races between 1952 and 1971.

Motor-cycling events include road and track events for motor-cycles equipped with sidecars. A passenger is carried who can assist the driver, particularly when negotiating bends.

Mountaineering is mountain climbing. Many people who climb do so only for the sport or challenge of the activity, but others are scientists collecting geological and weather observations. In either case, climbing is a risky business because of accidents on the rocks and ice, avalanches that can bury climbers under feet of snow or sudden storms that may leave them stranded.

Mountaineers wear protective clothing. They wear boots with rubber *cleats* (wedges) on the soles for sure footing. On ice, they attach *crampons* (metal spikes) to their boots. Climbers always carry ropes, which tie the members of the party to one another so that if someone slips the others break his fall. Ropes are also useful for climbing overhanging rocks and for coming down slopes quickly. In icy conditions, a long-handled *ice-axe* is standard equipment. This is used for *sounding* (testing) the ice, for cutting steps into it, and for balance. At very high altitudes climbers carry oxygen equipment for

breathing. Even so, they must go very slowly. Because high and difficult peaks take weeks or even months to ascend, expeditions set up base camps along the route, from which supplies are taken. At night, the climbers sleep in light-weight tents, which they carry on their backs.

Although men have been climbing mountains for hundreds or even thousands of years, modern climbing dates from the 1850's, when the alpine clubs and other climbing organizations were formed in Britain and other countries. During the late 1800's, many well known peaks in Europe, Africa, North America and South America were scaled. The world's highest mountain, Mount Everest (29,028 feet) in the Himalayas, was first climbed in 1953 by Sir Edmund Hillary and Tenzing Norgay. The ascent took more than two months.

Mountains cover vast areas of the Earth's surface. The Rockies of North America, the Andes of South America, the Alps in Europe, and the Urals and Himalayas in Asia are among the largest and most spectacular of the world's mountain ranges. The Himalayas are the most magnificent of all. There lie many of the world's highest peaks including Everest (over 29,000 feet). For this reason the Himalaya range is often referred to as 'the roof of the world'.

Mountainous regions are often breathtakingly beautiful, with snowcapped peaks, ice-blue lakes, and cascading waterfalls. But they can also be extremely dangerous. Rock falls, avalanches, and treacherous weather conditions can turn even a simple mountain walk into a desperate fight for survival.

Mountains are a feature not only of the land, but also of the oceans. Sometimes these *submarine* mountains reach the surface of the ocean and form islands. The Bermuda Islands and the Azores are examples of this. The ocean bed, like the land, is criss-crossed with mountain ranges, plains, and deep valleys.

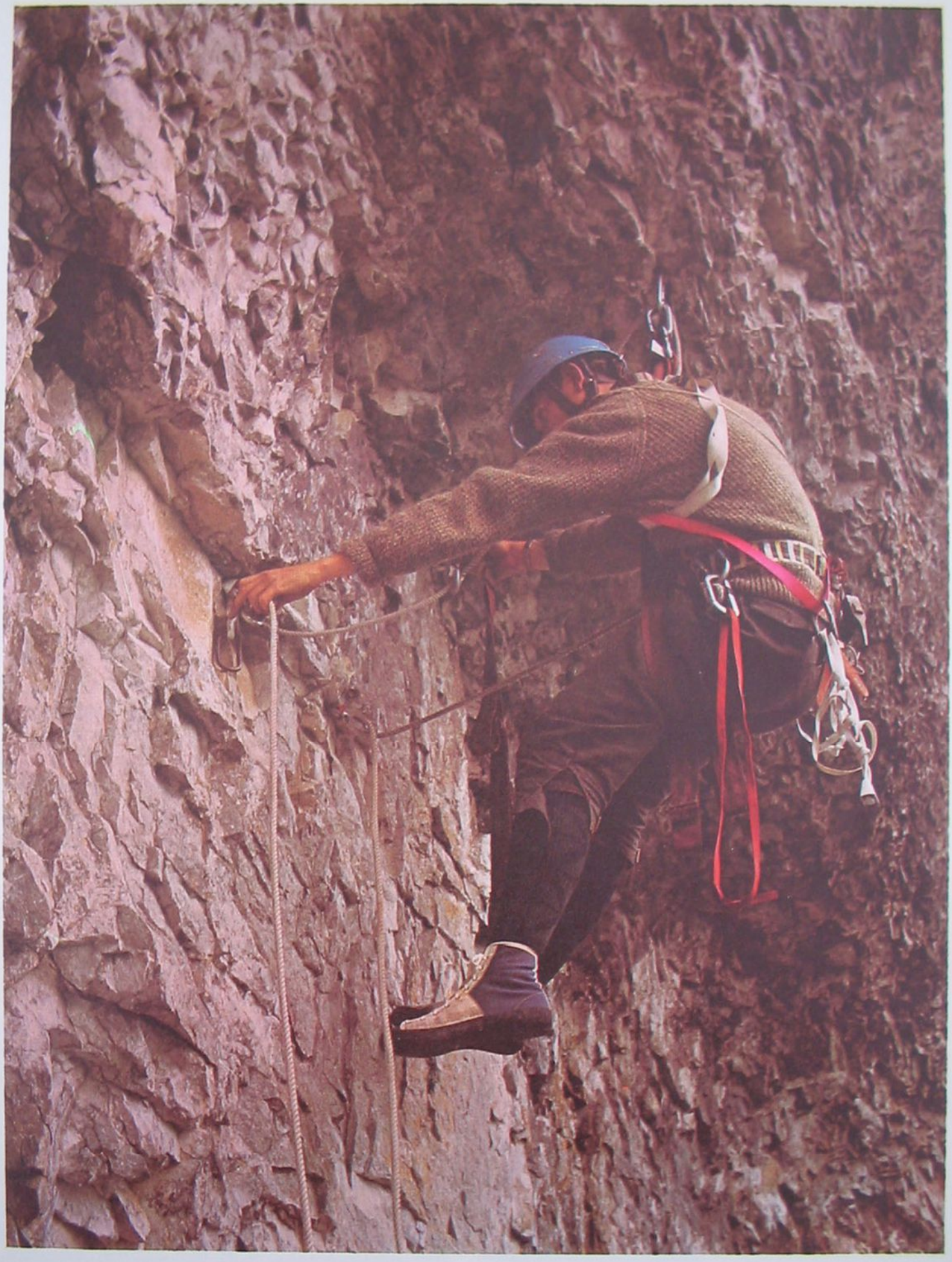
Mountains are formed as a result of movements in the Earth's crust. The devastating earthquakes that often occur in Persia, South America, Japan, and other regions provide us with a constant reminder of the fantastically powerful forces at work inside the Earth.

These earth movements give rise to three basic kinds of mountains—fold, block, and volcanic. *Fold mountains* form when two ancient land masses move towards each other and compress the land in between. The compression forces the land into great, wave-length folds. The Swiss Alps in Europe are examples of fairly young folds (about 15 million years old). The highlands of Britain are examples of old folds (about 240 million years old).

Sometimes earth movements may produce lines of weakness in the Earth's crust called *faults*. As the movements continue, great, block-like masses of the crust move along the line of the faults. They may subside below or be raised above the general land level to form *block mountains*, such as the Sierra Nevada in the

The most recent of the mountain areas to be built was the great system of mountains that stretches from Europe to the Java Sea, and includes the Alps (below).

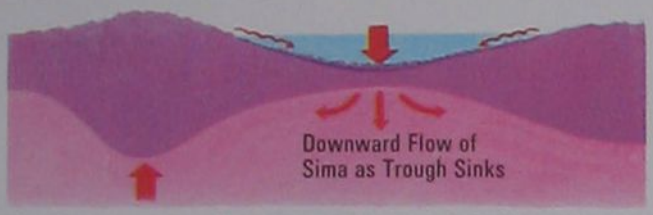
Mountain climbing is a hazardous but very popular sport. Experienced climbers observe strict safety rules.



United States. Long, deep valleys formed by land subsiding between parallel faults are called *rift valleys*. The best-known example of a rift valley is in East Africa and includes the Red Sea.

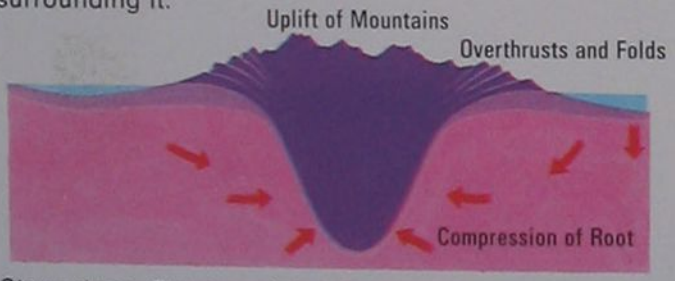
From the day they are formed, mountains are subjected to the continuous action of the weather. The rain beats down, the sun scorches, and the frost freezes and shatters. Even the hardest rock becomes worn away in time. Rivers flow through and deepen the valleys. At high altitudes frozen 'rivers' of ice called *glaciers* form. They grind their way downwards widening and scarring the valleys.

Mountain Building

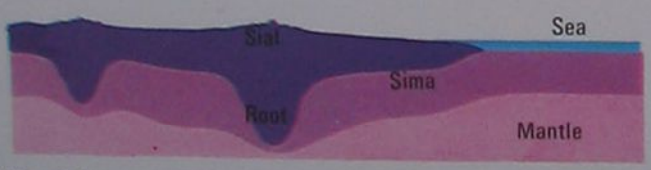


The first stages of the orogenic cycle. Sediments accumulate in the sinking trough.

The trough fills at the expense of the rising land surrounding it.



Stage three. The trough has been compressed, so that at the end of the second stage the sediments are buckled up and folded over the edges of the trough. The mountains gradually rise to regain balance.



Mountain ranges and lowland plains behave in the same way as large and small icebergs, and tend to 'float' on the denser material below.

Mouse A mouse is a small furry member of the order of gnawing mammals called *rodents* (see Rodents). Like its close relative the rat, the house-mouse is a pest that has followed man to almost every part of the world (see Rat). It does much damage in food stores, sleeping in quiet places during the day but coming out to feed at night. Mice breed rapidly, producing several litters each year. Man has used cats to catch mice for thousands of years. But mice also make good pets. Some other kinds of mice are outdoor creatures. They include the harvest-mouse, which makes a globe-shaped nest among the stems of a wheat field.

Mozambique is a province of Portugal located on Africa's south-eastern coast. With an area of 302,330 square miles, it is much larger than Portugal itself. Mozambique's harbours at Lourenço Marques (the capital) and Beira serve the shipping needs of neighbouring African countries, to which they are linked by rail: The vast majority of Mozambique's 7,376,000 people are Africans of Bantu-speaking tribes. Many of them work in South African mines and farms. Others work on Mozambique's own farms, which are mostly in the fertile river valleys. Cashew nuts, cotton, sisal and sugar-cane are important crops. Tea grows in the highlands.

Vasco da Gama discovered Mozambique in 1498. Portuguese settlers arrived during the early 1500's, and the region became

This location map shows the position of Mozambique.

important in the slave-trade. Private companies controlled the province from 1891 until 1942, when the government took over. Mozambique is the last large African country that is still dominated by a European nation. In the 1960's and early 1970's, Portugal has had to maintain a large army in Mozambique to contain terrorist guerillas fighting for independence.

Mozart, Wolfgang Amadeus (1756-1791), was one of the most outstanding composers of all time. He showed an astonishing ear for music when he was only three years old, and within a few years was able to play several instruments.

He was born in Salzburg, Austria, where his father was a musician at the court of the Archbishop of Salzburg.

Mozart began his professional career when he was six by touring Europe with his father and his sister, who was a talented singer. They were acclaimed wherever they performed, and the young Mozart began to compose the first of his many works.

His great genius was his ability to compose virtually every form of music, including operas, choral music, orchestral music, and chamber music.

Mozart wrote some of the finest operas ever written, *The Marriage of Figaro*, *Don Giovanni*, and *The Magic Flute* being particularly successful and popular. Among the forty symphonies that he composed, the *Jupiter* or *Symphony in C major*, the *Symphony in G minor*, and the *Symphony in E flat major* are regarded by many as his finest. Other notable works are the *Eine Kleine Nachtmusik*, which is a serenade, and the *Sinfonia Concertante*, a concerto for violin and viola.

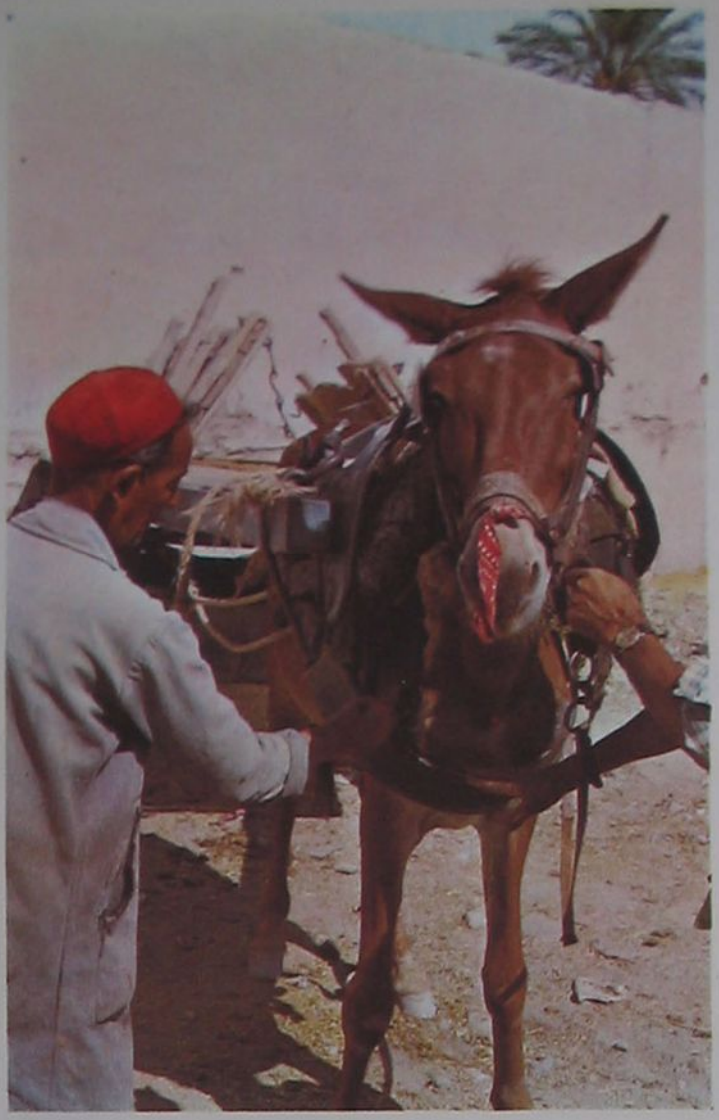
After his death, Mozart's works, which consisted of more than six hundred pieces, were classified by an Austrian scientist Ludwig von Köchel. Each composition is now to be found with the letter K and a number after it. Mozart wrote so much music in his short life by composing at immense speed; in 1788, he is thought to have written three complete symphonies in the space of 42 days.

Despite his successes he spent much of his life in poverty, and his health suffered as a result. He died when only thirty-five, and was buried in a pauper's grave in Vienna.

Mule is a horse-like animal that is the offspring of a male donkey and a mare (female horse). The offspring of a she-

Above: Mozart played the harpsichord at the age of three. At six he was taken on concert tours all round Europe. Gustave Boulanger's painting shows Mozart playing at Vienna.

Left: A portrait of Mozart in his twenties.



Mules are widely used in poorer countries as beasts of burden. Strong and sure-footed, they have great endurance.

donkey and a stallion (male horse) is called a hinny. Mules are nearly always sterile (they cannot produce young). They are tough, hardy animals, with greater endurance than a horse, and are often used as beasts of burden over rough, mountainous country.

Mummy A mummy is a specially preserved dead body. The name comes from an Arabic word 'mumiya', which means 'bitumen'; and this comes from a Persian word 'mum', which means 'wax'. Belief in a life after death has led many peoples to try to keep the bodies of their dead from rotting, so that the body would be ready for the return of the spirit. Preserved bodies have been found in caves in South America. It was the ancient Egyptians, however, who really became masters of the art of *embalming* (preserving dead bodies). Bodies were drained of fluids, treated with preservatives, covered with bitumen, and then wrapped in linen cloths. This was the mummy; it was placed in a casket on which the dead person's face was painted.

Embalming the dead is quite common, today, in the United States. In the U.S.S.R. the dead leader Lenin has been embalmed. Lenin's body is on show in the Red Square in Moscow, though he died in 1924, but he is not wrapped up like a mummy.

Munich is one of West Germany's leading cities, with more than 1,326,000 people. It lies on the banks of the River Isar, in the southern state of Bavaria, of which it has been capital since 1508. A beautiful city with many parks, it is also proud of its museums, libraries, theatres and opera house. It is well known for its beer-drinking festivals, particularly the *Oktoberfest*.

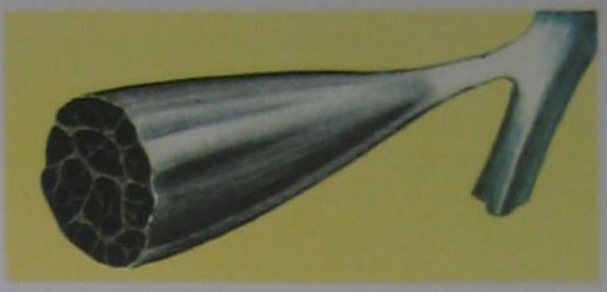
Munich has many different industries. They include brewing, engraving, engineering and the manufacture of cars, optical instruments, food products, church bells and stained glass. The city was

An Egyptian mummy. The body was soaked in chemicals, stuffed with sawdust, and wrapped in linen bandages. The mummy might be contained in the innermost of a series of coffins. The outer coffin is known as a Sarcophagus.

founded in 1158 near the site of a monastery. It became a dukedom in 1181, and remained so until 1919. The Nazi Party, founded in 1918, considered Munich its home. The Allies bombed the city heavily during World War II.

Murray-Darling River is Australia's largest river system. The Murray itself rises in the Australian Alps and flows for 1,600 miles through New South Wales, along the Victoria border, and into South Australia, where it finally empties into the sea at Lake Alexandrina near Adelaide. The Lachlan, Goulburn and numerous smaller rivers feed it. At Wentworth, it picks up water from the 1,700-mile-long Darling, which is the continent's longest single river.

The Murray and its tributaries provide hydroelectric power and also water for irrigating the dry surrounding countryside. The Hume Reservoir and others store water for use in dry years. Grapes, oranges and other fruits and grain grow in the irrigated river basin. Sheep graze on the grasslands. The river was once an important means of transport, but has given place to improved road and rail communications.



A muscle may be made up of many large bundles of muscle fibres. Each bundle is composed of smaller bundles of fibres.

The Achilles' tendon joins the calf muscle to the bone of the heel. In movement, the bone acts as a lever operated by the muscle, just as levers are used to move heavy weights.

Muscle is the fleshy tissue that controls the movements of our bodies. When we turn our head, bend our arm, or pick up something, we use muscles.

These actions are all carried out by *voluntary* muscles—those under the conscious control of the brain. These are also called *skeletal* muscles, because they are attached to the skeleton, generally forming a bridge over a joint. The attachments are tough cords called *tendons*. When you want to move your arm, your brain sends a nerve signal to the arm muscles. These contract (shorten) and pull on the tendons which pull on the arm bones to which they are attached, and the arm moves.

Some muscles are *involuntary* (not under conscious control). They do such jobs as opening and closing the ducts of glands, churning food in the stomach and regulating the size of blood vessels.

All muscles are composed of hundreds of fibres. Those of voluntary muscle are each about 1/250 of an inch thick and up to three inches long. They are marked with alternate light and dark bands. For this reason, voluntary muscle is also called *striped* muscle. The fibres of involuntary muscle have no markings, and so it is called *smooth* muscle. The fibres are also much smaller—only about 1/120 of an inch long and 1/4000 of an inch thick. The muscle of the heart—*cardiac* muscle—looks like striped muscle but functions like smooth muscle.

Left: Formerly one of the old royal palaces of Paris, the Louvre was extended by Napoleon to house works of art plundered from foreign art galleries.

Museums are places where all kinds of objects of interest to people are stored and put on display. Such objects vary from coins and pottery to aircraft and skeletons of dinosaurs. Some things seen in museums may be of very little value while other objects may be almost priceless.

The first museums we know of were in Greece and Egypt during the third century B.C. The most famous of these was at Alexandria in the palace of the Ptolemy rulers of Egypt. Museums were unknown in the centuries which followed. During the fifteenth and sixteenth centuries rich men and scholars began to collect paintings and Greek and Roman objects, and in the seventeenth century objects of interest to scientists were also collected. These collections were often displayed in private museums. It was not until the nineteenth century that the idea of opening museums for everybody to use became common.

There are many kinds of museums today. Most countries have famous museums in which are kept objects collected from many lands. Among such museums are the British Museum (London), the Louvre (Paris), the Hermitage (Leningrad) and the Metropolitan (New York). Many large cities have good museums with general collections. There are also museums which display objects collected from the neighbourhood or of interest to the local people. Some museums only keep objects connected with one subject, such as natural history, or science, or warfare; others display exhibits concerning the life of a famous person.

Most museums take great care to display objects well. Small articles are put in glass cases whilst big exhibits are hung on walls or put in large halls. Everything is arranged in subjects, and most articles have labels giving information about them. The people who work in museums are experts who often write books about the most important things in their care. Sometimes old objects have to be care-

fully repaired or old paintings cleaned and restored, and this needs great skill.

In these and many other ways museums are interesting places which play an important part in storing and spreading knowledge and give delight to many people.

Talking points

* In some countries, museums have no entrance charge to the public; in others one has to pay to go in. Do you think that you should have to pay to visit a museum?
* What is the most important function of a museum? Is it to preserve the past, to give pleasure to people or to instruct them?
* Museums often have to pay huge sums of money to purchase the articles that they want to exhibit to the public. How do they obtain the money they need for this?

Articles to read

Antiques; Archeology.

Mushrooms and toadstools look like little umbrellas growing in the ground. You find them in woods and fields, particularly in the autumn. Mushrooms and toadstools are among the commonest and certainly the most obvious members of a much larger group of plants called *fungi*. In common with all other fungi they have no chlorophyll and, as a result, are unable to make their own food (see Photosynthesis). Most live as *saprophytes* – that is, they extract their food from dead organic matter such as wood or soil humus. Some species, however, are *parasites* and get their food from living organisms.

The familiar umbrella you see is only a small part of the whole fungus. Most of it lies beneath the ground or buried deep in wood and consists of a mass of thin threads. The umbrella is merely the structure that bears the spores and is often called the *fruiting body* of the fungus. Spores are the means by which the mushroom or toadstool reproduces itself. It is important that the spores do not germinate near the parent plant, or many will perish. For this reason, the fruiting body appears above the ground so that wind currents will bear the spores far away.

The fruiting body bears the spores on a

The Museum of London's Commonwealth Institute gives people a picture of different Commonwealth countries.

special layer of cells called a *hymenium*. There are several families, based upon the arrangement of the hymenium. In the *Agaricaceae*, to which typical mushrooms and toadstools belong, the hymenium is distributed over a number of plates called *gills*. The gills hang down from the underside of the umbrella, and splay out from the centre like the spokes of a bicycle wheel. The corrugation caused by the gills greatly increases the surface of the hymenium and means that it can house far more spores than it could if it was flat. The top of the umbrella keeps the rain off the spores, while the stalk holds the hymenium well up to catch the wind. Some toadstools have *pores* on the underside of their cap rather than gills.

The fruiting body develops as a little ball beneath the ground. It then absorbs water and bursts out of the soil. The hymenium is commonly covered by a skin-like veil, which stretches from the rim of the cap to the top of the stalk. When the cap expands, the veil splits, leaving a little ring round the stalk. You can see this on a mushroom. The fruiting bodies of some species are completely enclosed in a membrane before they burst above the ground. The ruptured jacket then remains as a cup round the bottom of the stalk. A very poisonous toadstool called the death cap has both a ring round the top of the stalk and a cup at the bottom. These features, together with the white cap and gills, distinguish the death cap from the edible mushroom, and from other harmless species.

Opposite: The common mushroom starts life as a single thread, which branches and eventually joins another (top of page).

1. Horse Mushroom (*Agaricus arvensis*)
2. Oyster Mushroom (*Pleurotus ostreatus*)
3. Parasol Mushroom (*Lepiota procera*)
4. St. George's Mushroom (*Tricholoma gambosum*)
5. Turban fungus (*Gyromitra esculenta*)
6. Chanterelle (*Cantharellus cibarius*)
7. *Amanita caesarea*
8. Morel (*Morchella vulgaris*)
9. *Clitocybe geotropa*
10. *Boletus luridus*
11. Grisette (*Amanita vaginata*)
12. *Lactarius zonarius*
13. Shaggy Cap (*Coprinus comatus*)
14. *Lactarius volemus*
15. Cage fungus (*Clathrus cancellatus*)
16. *Clavaria flavia*

Bottom of page: When the fruiting bodies of the mushroom are nearly complete, they grow rapidly by absorbing water. The cap then breaks away from the stalk, exposing the gills.

Music is a pleasing combination of sounds made by the vibrations produced by musical instruments or by the human voice. It can be divided into three parts: *melody*, *harmony* and *rhythm*.

A melody is a tune. Nearly all pieces of music contain tunes. Some are very easy to follow, such as the tune of a folk-song, or the latest recording of a 'pop' group. Others, such as the many little bits of tune in a *symphony* (piece for orchestra), may be harder.

Harmony is what we call the combined sound when several notes are played at once. A group of such notes is called a *chord*. Sometimes musicians produce a form of harmony by playing two or more tunes at once, called *counterpoint*.

Rhythm is the regular 'beat' of music. It is the simplest kind of music known. The earliest men and, today, people living in primitive tribes beat rhythms out on drums or even on pieces of wood. Rhythm is natural to man. He breathes regularly, his heart beats regularly and when he walks he puts his feet down rhythmically. The earliest musicians soon found that they could make different kinds of sounds to add to the rhythm. For example, they could sing or whistle notes of different pitch—that is, high or low—and could hit stones or blow through reeds to make different sounds, too.

The people of the early civilizations, such as those of Egypt and Greece, made music. But we do not know what it sounded like, because there was no way of writing it down or recording it.

Until the late Middle Ages, most music was played or sung for a specific purpose—for example, for dancing or working or as part of a religious service. Much old music that survives is church music.

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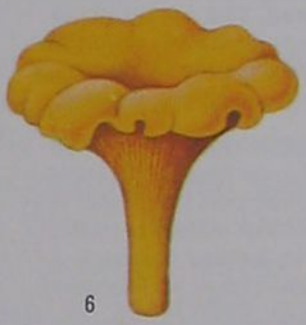
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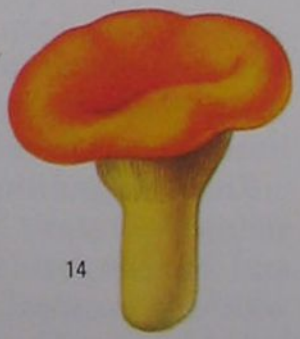
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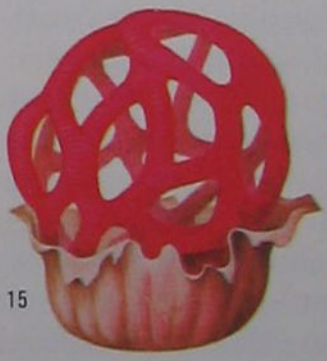
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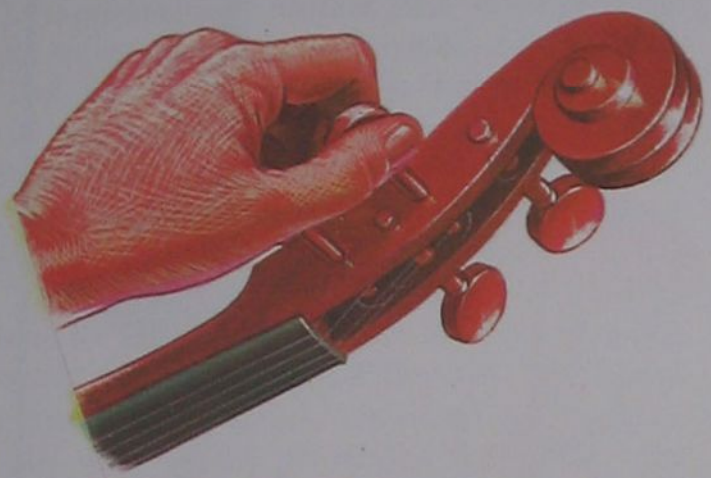
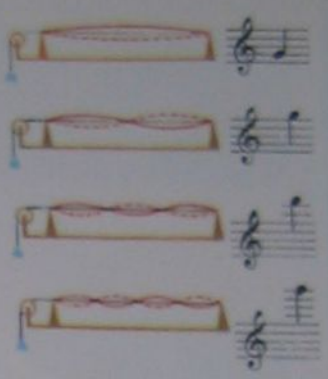


Right: A string of given length and tension vibrates in several ways at the same time. The different vibrations produce harmonics. Top to bottom: Whole length of string produces fundamental note. One half of string produces 2nd harmonic. One third of string produces 3rd harmonic. One quarter of string produces 4th harmonic.



Above left: The body of the violin resonates when the strings are bowed.

Below left: The strings of a violin are tuned by being tightened or slackened. The player turns pegs to which they are attached while plucking or bowing the strings.

Below right: Countries all over the world have developed their own distinctive styles of music. The picture shows a flute-player in Morocco.

By 1500, people were playing and singing music that was recognizably similar to the music of today. They had invented many instruments similar to violins and guitars; and trumpets, flutes and similar wind instruments.

A big advance in music came around 1600 with the invention of *opera*, a kind of play in which all the words are sung (see Opera). An Italian, Claudio Monteverdi, was one of the earliest opera composers. He also formed one of the earliest *orchestras*, a large body of musicians. Counterpoint was the most popular way of writing music until the 1700's. Two Germans, J. S. Bach and G. F. Handel, were among the last and greatest writers of counterpoint. From the mid-1700's, musicians concentrated more on melody, with harmony to accompany it.

Orchestral music as we know it today was evolved and perfected by Joseph Haydn, Wolfgang Mozart, Ludwig van Beethoven and others in the late 1700's and early 1800's. Later musicians experimented with combinations of sounds and developed the possibilities of various instruments.

In the 1900's, musicians such as Arnold Schönberg have experimented with more difficult tunes and rhythms. Others such as Karl-Heinz Stockhausen have used tape recorders to produce strange-sounding electronic music.

Musical Instruments produce sound in many ways. But they all depend on vibrations to produce sound waves in the air.

In *stringed* instruments, a stretched string vibrates. The violin, viola, cello, and double bass each have four strings, which are caused to vibrate with a bow or by plucking. The player varies the pitch of each string by pressing it at one point against a finger-board—the shorter the length of the vibrating string, the higher the pitch of the sound. The heavier strings produce lower notes.

Stringed instruments such as the guitar, harp, lute and banjo are always plucked.

The guitar, lute and banjo have *frets* on the finger-board to help the player place his fingers accurately. On the harp, there is a separate string for each note, although the length of each string can be varied by pressing pedals at the base.

In the dulcimer, which like the harp has separate strings for each note, the strings are struck by hammers. In the piano, the strings are struck by hammers operated by a keyboard (see Pianoforte). Other keyboard instruments with strings are the harpsichord, in which the strings are plucked by quills, and the clavichord, in which they are struck by metal wedges.

In *wind* instruments a column of air vibrates. In woodwind instruments, the vibration is caused by a *reed* attached to a mouthpiece, as in clarinets and saxophones; by a double reed, as in oboes and bassoons; or by blowing across a hole in the instrument, as in flutes and piccolos. All woodwind instruments have holes that are covered by the fingers or by pads operated by the fingers. These alter the length of the vibrating column of air—the shorter the column the higher the pitch. In the recorder, a whistle or fipple mouthpiece causes the vibration.

In *brass* instruments, the vibration is caused by the player's lips vibrating in a cup-shaped or cone-shaped mouthpiece. The air column vibrates from the mouthpiece to the *bell* of the instrument. Several notes can be blown in this way, and these are the notes used in bugle calls. In brass instruments other than the bugle, the air column can be lengthened. In horns, trumpets, and tubas, the air column is diverted into pieces of side-tubing by pressing valves or pistons. Six more notes are obtained in this way for each note obtained by a certain lip pressure. In the trombone, the slide is moved to vary the length of the air column.

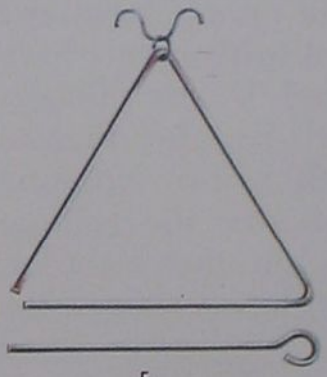
The organ is also a wind instrument

Greek women playing harp, cithara, and lyre. (Fifth century B.C.)

of a kind. Each note is produced by a separate pipe into which air is blown by pressing a key (see Organ).

In *percussion* instruments, a taut skin or a piece of metal or wood is struck to produce a note. The note is usually of short duration. There are two kinds of percussion instruments: *definite pitch* or *tuned* percussion and *indefinite pitch* percussion. Tuned instruments include the timpani—large drums in which the tension of the skins can be varied. In the vibraphone and xylophone, metal or wooden bars tuned to various notes and arranged like the piano keyboard are struck with mallets. In the celeste, small hammers operated by a keyboard strike metal plates. Indefinite pitch instruments include drums, cymbals, gongs, tambourines, and triangles.

Several popular and folk-music instruments depend on the vibration of reeds to produce the sound, without causing an air column to vibrate as in woodwind instruments. The mouth-organ, concertina, and accordion have a reed for each note. The mouth-organ is blown directly, but the concertina and the accordion have bellows to produce the air flow. In bagpipes, a set of vibrating reeds produces the drone. The tune is played by a chanter with holes like a woodwind instrument. The bag is blown up by the mouth and squeezed under the arm to produce the air flow.



Musical Instruments

1. Violin
2. Bass drum
3. B-flat clarinet
4. French horn
5. Triangle
6. Electric guitar
7. Trumpet

In many modern musical instruments, the sound is produced by electrical means, amplified, and fed to a loudspeaker. The most popular instrument of this kind is the electric guitar.

Mussolini, Benito (1883-1945), the founder of the Italian Fascist party, was dictator of Italy from 1922 to 1943. Known to his supporters as *Il Duce* (the Leader), Mussolini and his Fascist Grand Council rigidly controlled the lives of the Italian people and allowed almost no opposition to Fascist policies.

Mussolini entered politics as a socialist. He edited the socialist newspaper *Avanti*, but in 1914 founded his own newspaper *Il Popolo d'Italia*. In 1921 he organized the Fascist party with the aim of building a new and powerful Italy. After the Fascist 'March on Rome' in 1922, King Victor Emmanuel III called on Mussolini to form a government. Before long, the Fascists were in complete control of the country.

Mussolini's troops invaded Ethiopia in 1935, and conquered it after a savage campaign. Later, Italian forces were sent to help General Franco in the Spanish Civil War. In 1940, Italy entered World War II on the side of Germany, but suffered defeats for which Mussolini was blamed. He was overthrown and imprisoned, but, after rescue by the Germans, became head of an ineffective puppet government. In 1945 Italian resistance fighters captured and executed him.

Mycenae was an ancient city on the mainland of Greece. It was the centre of a powerful prehistoric civilization that dominated the Aegean Sea from 1400 to 1150 BC. Most of our knowledge of Mycenae comes from the excavations carried out by Heinrich Schliemann, a German archaeologist, in 1876. Schliemann hoped to find sites described by the Greek poet Homer.

Mycenae was a fortified city with a royal palace. At the entrance stood a gate with

The lion gate at Mycenae was built about 1350 B.C. The central pillar may have supported the figure of a goddess. Mycenae was excavated by Heinrich Schliemann, a German archaeologist who was seeking Agamemnon's tomb.

figures of lions carved in stone. The kings were buried in tombs shaped like beehives. The Mycenaeans belonged to the late Bronze Age. They made armour, implements and ornaments of bronze, copper, gold and silver, but they did not work with iron. Clay tablets show that they used written script. Many of the objects found at Mycenae show that its civilization was in some way connected with that of the Minoans of Crete. Mycenae was burned in 1100 BC by Dorian invaders, and completely destroyed in 468 BC by armies from Argos, in eastern Greece.

N

Nairnshire (area 163 square miles) is a county on the north-east coast of Scotland, lying south of the Moray Firth. Its county town is Nairn, and its population is 11,000.

The coastline is fringed by sand dunes. Inland, there is a rolling, fertile plain, much of it wooded. There, dairy farming is a major occupation. Barley, oats and root crops are also grown. South of the plain the land rises to more than 2,000 feet. The uplands are devoted mainly to sheep-rearing. The principal rivers are the Nairn and Findhorn, and their tributaries. Nairn is a market town and a seaside resort.

Names are given to many things to identify them. Most names have an original meaning quite different from the character of the person or object to which they are given. Many people are called *Smith*, but they don't shoe horses or work metal for a living, as a smith does.

Personal names usually consist of at least two names: a first name and a surname. In between, there may be other names, such as more first names and family names. First names are often called *Christian* names, because they may be conferred on a child at a christening or baptism. First names may be descriptive in meaning: *Benedict* and *Clement* come from Latin words meaning *blessed* and *merciful*, respectively; *Helen* comes from Greek and means *bright*; *Grace* means what it says. First names may also have religious origins, particularly Hebrew. *John* means *Jehovah is good*, and *Elizabeth* means *God is good fortune*. Family names are surnames used as first names, such as *Russell* and *Nelson*. First names can exist in many forms and languages. *John*, for example, has the same origin as *Jack*, and in female names becomes *Jane*, *Janet*, *Joan*, *Joanna*, *Jean*, *Jenny*, *Jess*, and even *Nita*. In other languages, this name becomes *Jean* or *Jeanne* in French, *Giovanni* or *Giovanna* in Italian, *Juan* or *Juanita* in Spanish, *Johann* or *Johanna* in German, *Ivan* in Russian, *Sean* in Irish, and so on.

Surnames may also be descriptive. *Black*, *Brown* and *White* are common examples, perhaps originally referring to the colour of someone's hair. Many surnames are descriptive of an occupation, such as *Smith*, *Turner*, *Shepherd*, *Glover* and *Baker*. Some surnames derive from places, such as *Hill*, *Brooks* and *Ford*, and even cities, such as *London* or *Washington*. Many surnames have suffixes or prefixes meaning *son of*. *Fitz* or *Mac* at the start of a surname, and *son* at the end, all mean *son of*, as in *Fitzgerald*, *MacGregor* or *Johnson*.

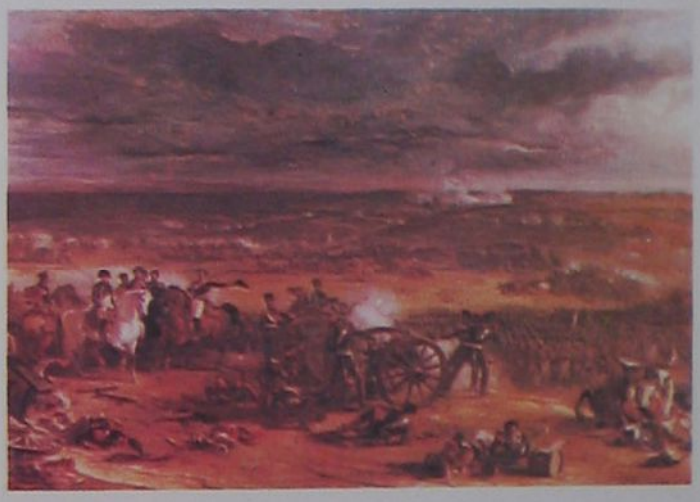
Place names are more accurate when descriptive. Many end in *ton*, *ham*, *thorp*, *wick* or *worth*, all of which are various terms for groups of dwellings. Thus *Weston* simply means *west town*.

Smith is the commonest name in the English-speaking world. There are about 800,000 people called Smith in England and Wales and over one and a half million of them in the United States. But Smith cannot compete with the Chinese name Chang, which some 75 million people bear.

Naples is a historic and important city in southern Italy. It has 1,278,000 inhabitants, making it the country's third largest city after Rome and Milan. The harbour does a good tourist trade and also exports wine, olive oil and fruit. Naples has shipbuilding yards and railway yards, steel plants, oil refineries and factories where *pasta* (spaghetti, macaroni etc.) and canned tomatoes are produced.

Visitors to Naples enjoy the view of the Bay of Naples, the hills rising gently behind the city and Mt. Vesuvius visible to the south-east. They can visit churches, medieval castles and a famous museum, and walk through the winding streets of the old section. Originally founded by the Greeks, Naples came under the political influence of Rome in the 4th century BC. It became an independent duchy in the 8th century AD, and was later the capital of the kingdoms of Sicily and Naples. It became part of Italy in 1861.

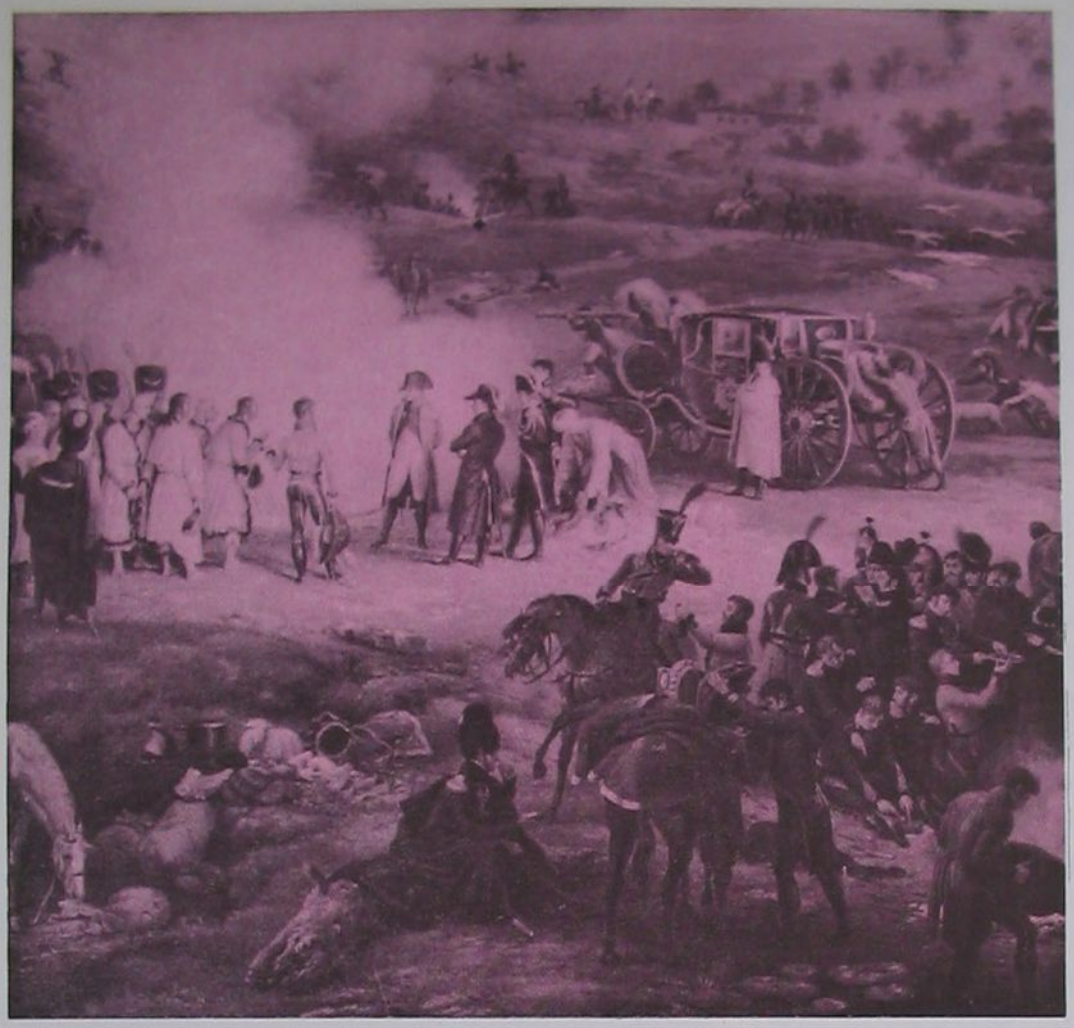
Above: Napoleon was affectionately known as the 'Little Corporal'. Below: The Battle of Waterloo, from a painting by William Allan. Here Napoleon suffered his final defeat at the hands of Wellington and the Prussian Blücher.



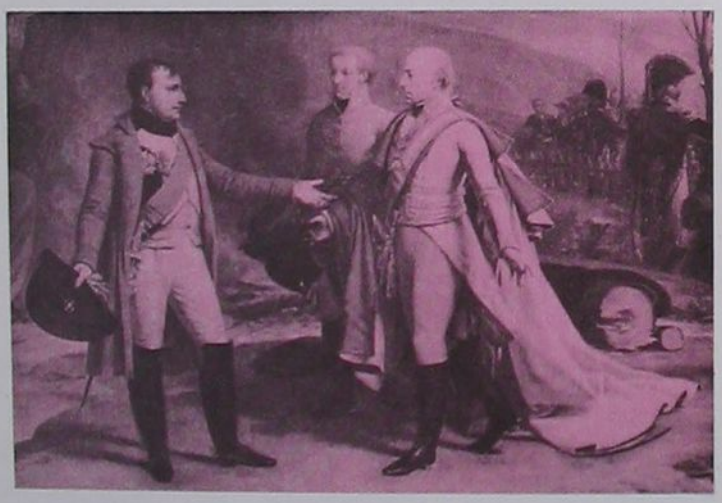
Napoleon Bonaparte (1769-1821) was one of the greatest soldiers in the history of warfare. After the French Revolution of 1789 had overthrown King Louis XVI and set up a republic, France offered great opportunities to ambitious men who could restore order. Napoleon Bonaparte rose to power rapidly—he was a military genius with a brilliant command of strategy. He was given power to bring order back into the country, but his ambitions for France led him to create an empire.

Napoleon was born at Ajaccio, on the island of Corsica, which belongs to France. He went to a cadet school at Brienne and to the leading military school in Paris. By 1792 he was a captain of artillery, and three years later saved the republic by crushing a royalist rebellion in Paris. With 30,000 starving, ragged soldiers, he took control of Lombardy, a province of Italy, and later won Belgium and some territory from Austria. In 1799 he saved the republic from rioters again. He seized power and ruled as a dictator. In 1804 he crowned himself emperor in the presence of Pope Pius VII in Paris.

In spite of many victories in Europe Napoleon was hampered by Britain's superior sea power. Nelson's defeat of the French and Spanish at Trafalgar in 1805 crushed Napoleon's hopes of invading England. Napoleon won further victories against the Austrians and the Prussians, and made his brothers Joseph and Louis kings of Naples and Holland. But his attempt to stop all European countries from trading with England failed entirely when Russia would not co-operate. He took a great army to Russia



Left: The French bivouac on the eve of the battle of Austerlitz. This was possibly the most conclusive of all Napoleon's battles. By brilliant tactics he crushed a combined Russian and Austrian army, and caused the break-up of the Holy Roman Empire.



Below left: The meeting of Napoleon and Francis II after Austerlitz; Francis was the Holy Roman Emperor, and had taken the title of Emperor of Austria. Napoleon created the Confederation of the Rhine in 1806. This deprived Francis of his German title, but was a major step in the creation of modern Germany.

in the winter of 1812 to force Tsar Alexander to submit, but the campaign ended in disaster.

Napoleon was defeated finally at Waterloo by the combined forces of Britain under Wellington, and Prussia, under Blücher, in June 1815. Napoleon surrendered to the British and was exiled on the island of St Helena, where he died in 1821.

Napoleon was a short man, and his stature earned him the nickname 'the little corporal'. But he was adored by his soldiers, and fired by great ambition. His rise to power was helped by the influence of his first wife, the beautiful Josephine de Beauharnais.

Napoleonic Wars The French Revolution made France many enemies in Europe and resulted in a series of wars which lasted with hardly a break from 1792 until 1815. During these wars France found a brilliant general in Napoleon Bonaparte. He won many victories, became sole ruler of France, and crowned himself emperor in 1804. But Napoleon's ambitions did not stop with the crown of France; he dreamed of ruling the rest of Europe as well. Consequently, the wars became a struggle against the ambitions of one man and for this reason are known as the Napoleonic Wars.

The chief enemies of France were Austria, Prussia, Russia, Britain and Spain.

Europe in 1812
At this period Napoleon was virtually master of Europe, with the only effective opposition coming from Britain and Russia, who were eventually joined by Prussia, Austria and Sweden. 1812 was the year of Napoleon's fateful Russian Campaign, which heavily depleted his forces and marked the beginning of his downfall.

The French armies were large, well-led and well-trained. They won many battles, the most important being at Marengo and Hohenlinden (1800), at Austerlitz (1805) and at Jena (1806). These victories gave Napoleon control over most of Europe.

However, the British navy was very powerful and in Lord Nelson Britain had an outstanding admiral. Nelson destroyed a French fleet at the battle of the Nile (1798) and so dashed Napoleon's hopes of conquering the East. Seven years later, Nelson defeated the main French fleet at Trafalgar and ended Napoleon's plans to invade Britain.

Napoleon next tried to ruin Britain by stopping all her trade with Europe. But the people of Europe needed British products and grew restless when goods became scarce and expensive. In 1808 the Spanish rebelled against Napoleon and a small British army, commanded by Arthur Wellesley, later Duke of Wellington, was sent to help them. Wellington won a number of battles and this persuaded Russia to re-enter the conflict. Napoleon led a huge army into Russia in 1812, but most of its 600,000 soldiers were killed in battle or perished in the bitter conditions of the Russian winter.

Encouraged by this disaster, Britain, Prussia, Russia, Austria and Sweden united against Napoleon. Their armies drove deep into France and occupied Paris (1814). Napoleon was banished to the island of Elba. In 1815 he escaped and rallied the French armies but was finally defeated on the battlefield of Waterloo by British and Prussian forces.

Peace had come at last to Europe. Napoleon was exiled to St Helena and the countries of Europe were handed back to their traditional rulers.

Natal is the smallest of South Africa's four provinces. It is located on the country's east coast, and has an area of 33,580 square miles. Durban, an Indian Ocean port, is the largest city, but Pietermaritzburg is the administrative capital. Of Natal's 2,977,000 inhabitants, about three-quarters are Bantu. The rest are Europeans or Indians.

The Drakensberg mountain range rises on the western borders of Natal. Cattle and sheep graze in the foothills. Near the coast, the land becomes low-lying, with a warm, humid climate suitable for growing sugar-cane, the province's main crop. Cotton, citrus fruits and maize also

grow in Natal. Coal is the chief mineral. Whaling in the Indian Ocean is an important activity. Almost all manufacturing industries are located in the Durban area. Factories produce textiles, soap, furniture, refined petroleum and tanning extract.

Vasco da Gama first sighted Natal in 1497, but the region was not settled until the arrival of the British in 1825. In 1838, the Republic of Natal was established by *Boers* (Dutch settlers) who had trekked from the Cape and defeated the native Zulus. Britain took Natal in 1843, making it part of Cape Colony. Zululand was added in 1897. Natal joined the other three provinces to form the Union of South Africa in 1910.

National Anthems are patriotic songs played and sung on ceremonial occasions. They are played during national festivities and as greetings to visiting sovereigns and heads of state. They are played also at many public gatherings, from serious political rallies to sporting events, according to the customs of the country. The singing may be done by a solo performer, or by everyone present. Sometimes, the anthem is merely played, and no one sings.

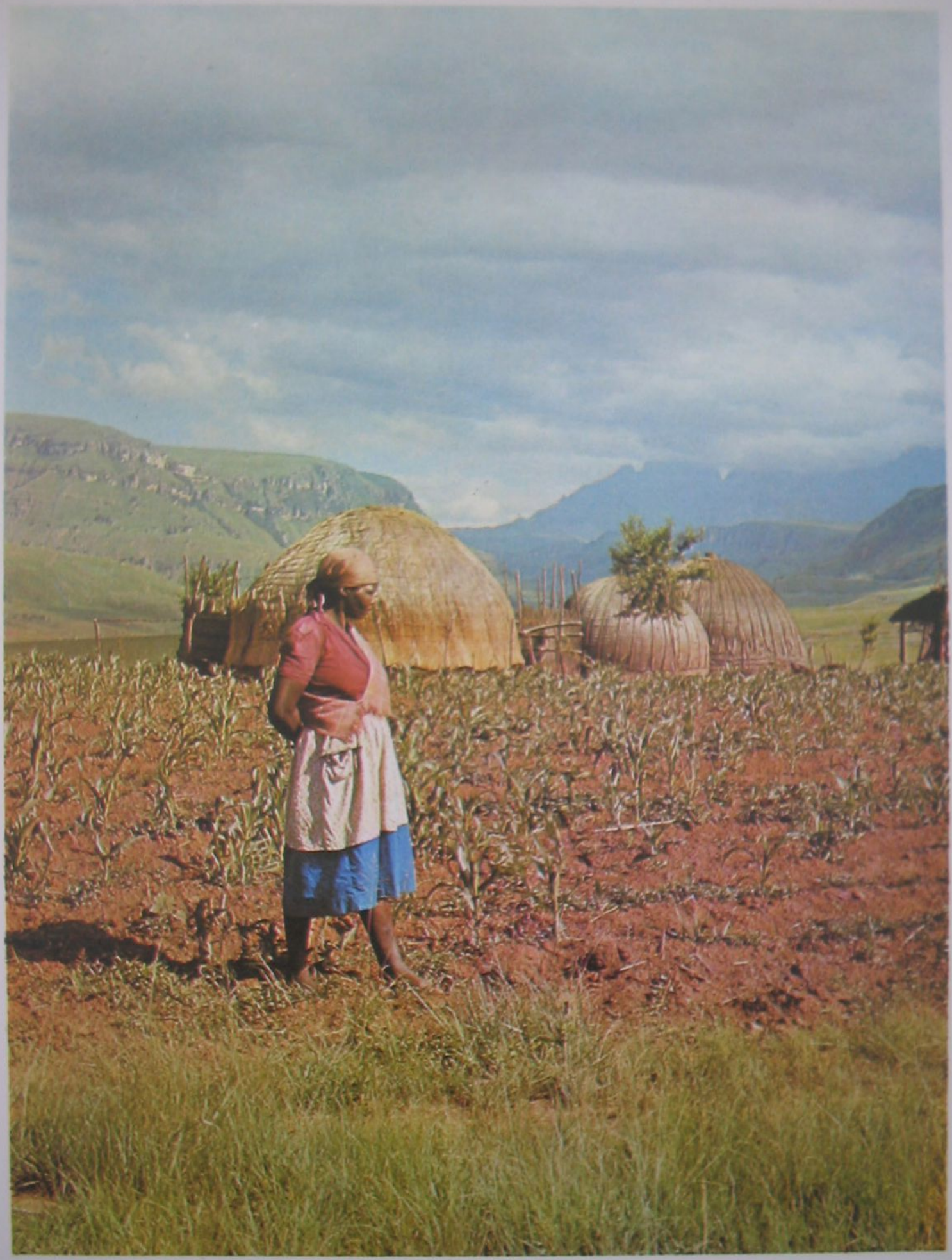
The words of a national anthem praise the nation and its people. Many of these songs are concerned with wars and revolutions. Among them is France's rousing national anthem, called *The Marseillaise* in honour of the citizen-soldiers of Marseilles, who marched to the relief of Paris during the French Revolution. Translated into English, it begins: "Forward, children of our country. The day of glory has come!" It was written and composed by a French soldier, Rouget de l'Isle, in 1792. *The Star-Spangled Banner*, national anthem of the United States, was also written in wartime. Francis Scott Key was a prisoner-of-war in 1814, when he wrote of "the rocket's red glare, the bomb bursting in air", and proudly, "gave proof, through the night, that our flag

The French National anthem was written by Rouget de l'Isle. This somewhat romantic painting shows him singing *The Marseillaise* in front of a group of friends.

was still there." The composer of the British anthem, *God Save the Queen*, is unknown, but the song was first sung in 1745, shortly after the Jacobite rebellion against the Crown had been crushed. Patriotic fervour runs high in defence of a nation. Thus Mexico's anthem begins: "Mexicans, at the call of war, Seize your swords and bridles!"

National Debt A country's national debt is the amount of money its government has borrowed from the people of the country and from other countries. Governments often borrow money when they need more money than they receive from taxes and other normal sources of revenue. Generally, the money they borrow is spent on such projects as building roads, hospitals, schools, or hydro-electric installations. In times of war a country's national debt always increases because of the vast amount of extra money that the government has to spend. Governments raise loans by selling bonds, certificates, and loan stocks to private individuals and institutions. Among the institutions, banks and insurance companies are often the largest buyers of government bonds and loan stocks. Many people invest their savings in government bonds or certificates to earn interest.

The money that a government borrows from other countries or from international bodies such as the International Mone-



The Drakensberg range rises in the west of Natal. The traditionally shaped 'beehive' huts are woven from grass and other local materials. Round them is a plot of maize or 'mealies'. It is the staple food of central and southern Africa. The people of this region are settled arable farmers. They speak a Bantu language.

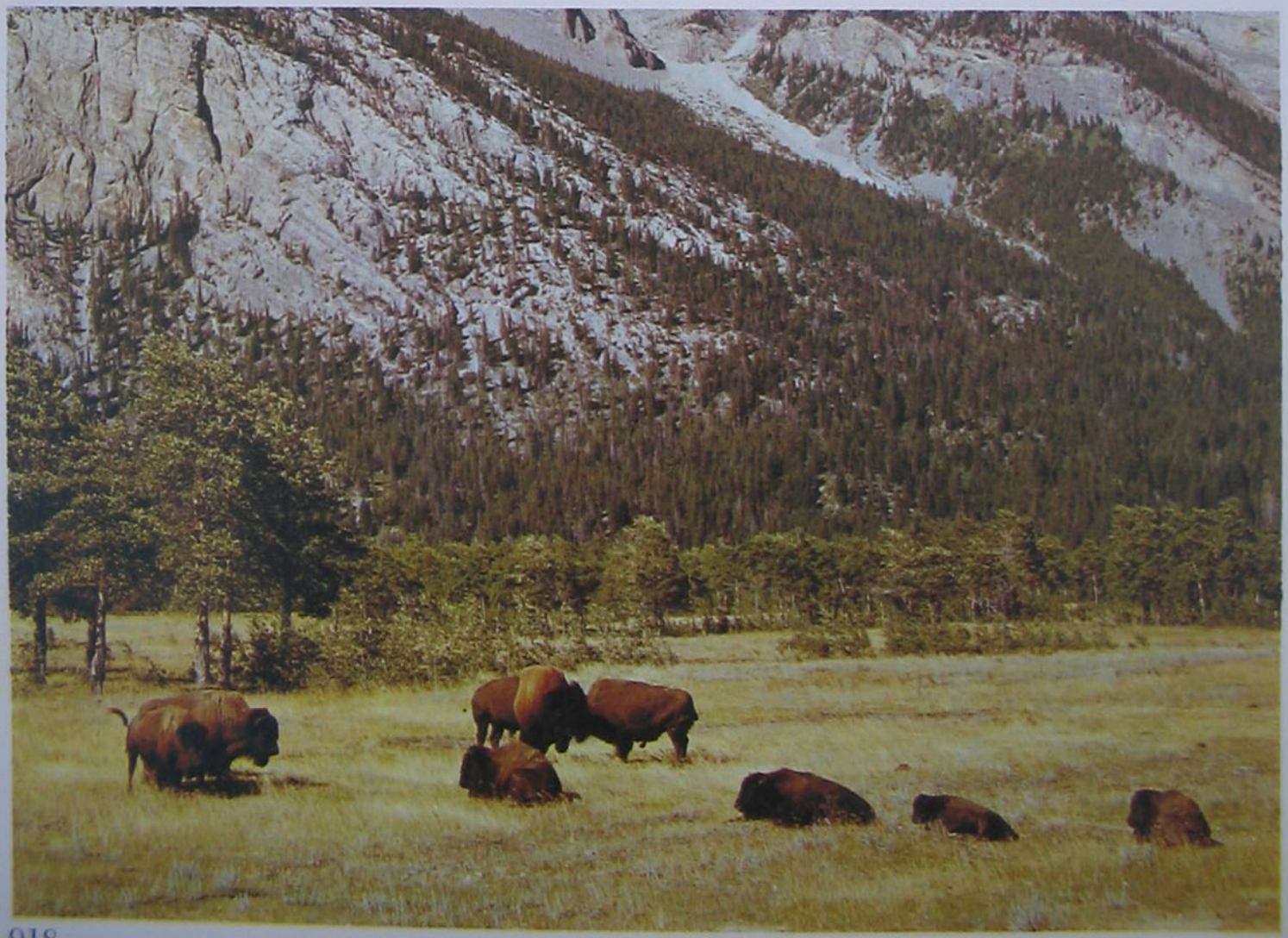
tary Fund is called its *external national debt*. A large external national debt greatly strains a country's resources.

National parks are special areas set aside to protect wildlife, magnificent scenery and plant life. Laws forbid hunting, building, mining, farming or forestry.

National parks became necessary as the population of the world increased. Vast forests were cut down and grasslands ploughed or used for grazing cattle and sheep. Farmers often killed wild animals because they damaged crops or attacked livestock. Other animals died because the plants that formed their food were cut down or burned. Some animals became extinct. Others, such as the bison of North America, nearly disappeared because men killed them in vast quantities for their skins and meat.

For hundreds of years, some people have tried to conserve wildlife and the wonders of nature. The Swiss established an area where hunting was forbidden in 1542. In 1872, the first American national park was established at Yellowstone in the north-western United States. Covering 3,471 square miles, Yellowstone is the largest national park in the United States. It contains several *geysers*—hot springs that erupt tall columns of steam and boil-

National Parks are often places where animals are protected in their natural surroundings.
Right: Lions in Wankie Game Reserve, Rhodesia.
Below: Bison in Banff National Park, Alberta, Canada.



ing water. By the early 1970's, the United States had 36 national parks.

Africa has many great parks, including the 8,000 square mile Kruger National Park in South Africa. There, visitors can see and photograph elephants, lions and many other animals roaming freely in their natural surroundings. Some Australian parks protect rare plants and such animals as the koala bear. A large park in New Zealand was established to prevent the notornis, a flightless bird, from becoming extinct. An Indonesian national park contains the last Java rhinoceroses.

Today most countries of the world have national parks, which are enjoyed by millions of people. In many countries of Africa, tourists from all over the world arrive to see the magnificent wildlife in the parks. As a result, tourism has become a major industry and source of income in many African countries.

Talking points

* The major function of national parks is to preserve species of animals that are in danger of becoming extinct. Can you discover any animal that has been saved from extinction by the setting up of a National Park?
* Draw an outline map of the world on tracing paper. Mark in the major National Parks and the animals that live in them.
* Many of the animals that live in national parks have become completely used to seeing human beings in motor cars and some have become semi-tame. Does the balance of nature get upset by the presence of cars and people?

Articles to read

Conservation; Ecology; Extinct animals; All articles on wildlife.

NATO takes its name from the initials of the *North Atlantic Treaty Organization*, a body that pledges to provide military assistance for its member nations should any of them be attacked. Membership is made up of the United States, Canada, the United Kingdom, Belgium, Denmark, Greece, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Turkey and West Germany. France withdrew in 1966. NATO came into being in 1950 and was designed mainly as a protection against the Soviet Union. United States nuclear power has always been its backbone. Besides defence NATO encourages peacetime relations and economic aid among its members. NATO's headquarters are in Brussels.

Natural gas is a mixture of gases which is often found where there is petroleum. But it is also found on its own. Natural gas has become an important fuel. It may be used by itself, or mixed with coal gas or oil gas.

Like petroleum, natural gas is composed of compounds of hydrogen and carbon, called *hydrocarbons*, which have a high heat value. The main hydrocarbons are methane, ethane, propane and butane.

Natural Gas

An off-shore drilling rig.

Right: Looking down the drill pipe. The helicopter is a valuable asset when the sea is rough.

Below: The drilling platform. There are a number of these rigs in the North Sea.

The United States and Russia are the world's biggest producers of natural gas. There are also vast gas fields in Canada, North Africa and the Middle East. In Europe, natural gas is produced from fields in Italy and France and under the North Sea.

Methods of prospecting and drilling for natural gas are similar to those used for petroleum. But great care is taken as the supply is struck because the gas is usually under great pressure and may also be very hot.

Pipelines, often hundreds of miles long, carry the gas to processing plants where it is purified. The gas may be piped directly as a fuel or it may be liquefied by cooling so that it can be transported to other countries.

A great deal of natural gas is used as a raw material for the chemical industry in much the same way as petroleum is. Plastics, dyes, explosives and drugs are some of the valuable end products.

Navigation is the method of finding one's way about the Earth's surface. Navigation is relatively easy on land. With the aid of good maps one can find one's way when walking in unknown country by observing landmarks, and road signs and other information help car drivers to navigate. But the navigator of a ship or an aircraft has no signs or landmarks to tell him where he is and in which direction he is going. Furthermore, ocean currents and winds may take the ship or aircraft off course. The navigator must check his position frequently and determine in which direction the ship or aircraft should be heading.

The navigator makes an estimate of his position by *dead reckoning* – he calculates the course of the ship from a known position by measuring its speed and time of

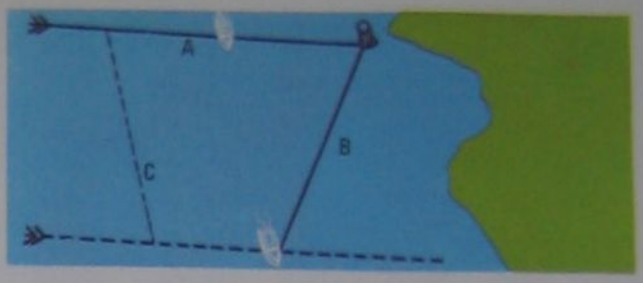
The Phoenicians were the first sailors known to have used the Pole Star for navigation. They laid the foundations of modern navigation. The magnetic compass did not appear in Europe until the 1100's. By that time it had already been in use in China for 2,000 years.

travel, allowing for currents and winds. But to make sure that he is on course, he must make accurate measurements of his position on the Earth's surface. There are two main ways of doing this: *celestial navigation* and *radio navigation.*

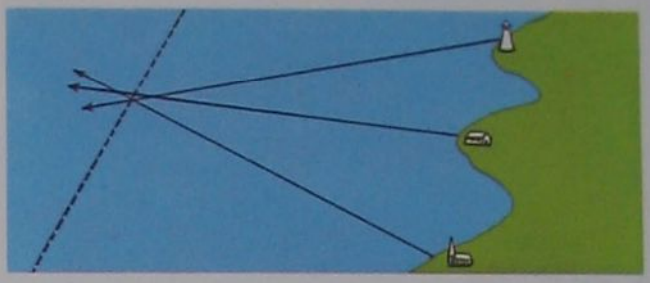
Celestial navigation depends on observations of the stars, Sun, Moon, and planets. The navigator uses a sextant to measure the angle a heavenly body makes with the horizon. (See Sextant.) Observations of the Sun give him a rough position, but to find it accurately he must observe the stars. He measures the angle or altitude of a certain star in the sky, its *bearing* (direction), and notes the exact time of the observation. By consulting tables, he finds the point on the Earth's surface directly below the star at that time. This is called the *substellar point.* The altitude of the star tells him how far he is from the substellar point, and he draws a line on his chart this distance from the substellar point and at right-angles to its bearing. This line is called a *line of position*, and the ship is somewhere along the line. By making observations of two more stars, he draws two other lines of position on the chart, and they cross at one point. This is the ship's position.

Radio navigation depends on observations of radio signals sent out by stations on shore or by satellites. Several shore stations send out signals of rapid *synchronized* pulses—that is, pulses sent out at exactly the same time. As the shore stations are at different distances from the ship, the signals take slightly different times to reach the ship and will be slightly out of synchronization. This gives the distances of the shore stations from the ship. In addition, their bearings can be found by using a rotating loop aerial. If the positions of the shore stations are known, the position of the ship can be found either from their distances or their bearings. *Satellite* navigation systems have been established by the United States. A series of satellites orbit the Earth broadcasting their exact positions as special signals. A computer on board the ship receives the signals, measures the change in signal as a satellite passes overhead (the Doppler shift), and calculates the ship's position to within 200 yards. The operation is entirely automatic. The liner *Queen Elizabeth 2* is fitted with this navigation system.

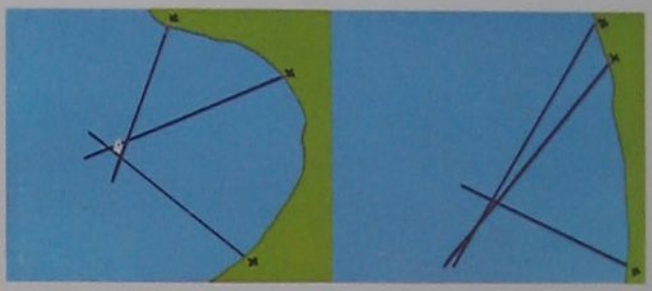
Once the navigator knows the ship's true position, he must make sure that the ship is heading in the right direction. This is done by using a compass. Magnetic compasses always point to the Earth's magnetic poles. (See Magnetic Poles.) Gyrocompasses contain a flywheel spin-



A diagram to illustrate the principle of a running fix. Line A is the first bearing, Line B represents the second bearing, taken half an hour later. Line C is the actual distance travelled during that time.



Three cross-bearings form a small triangle or 'cocked hat' owing to the inevitable minor inaccuracies.



Left: If the triangle has roughly equal sides it is safe to assume that the ship is in the centre. Right: A bad cocked hat. The triangle has unequal sides and the bearings must therefore be checked.

Above: Tanks roll past the saluting post during Hitler's 49th birthday celebration in Berlin.

Left: A flag displayed by the Hitler Youth.

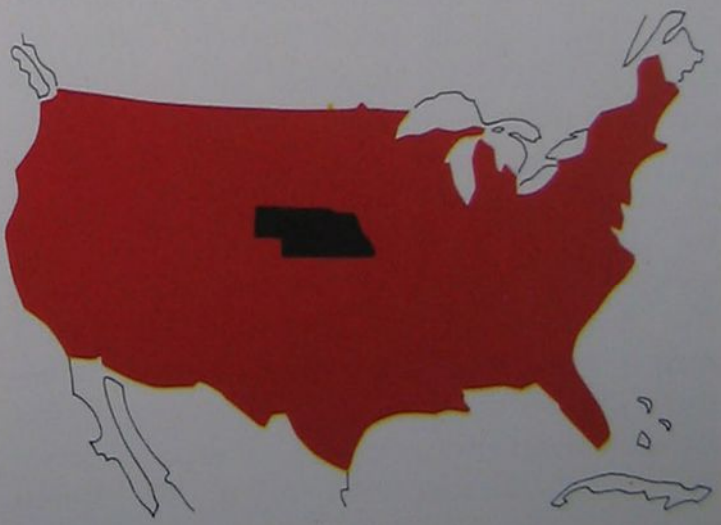
ning in a set direction. Once set to north, it does not move whatever the direction of the ship.

When a ship leaves port, it is guided by a pilot who knows the harbour. Near the coast, the navigator works by taking bearings of landmarks on the coast. Accurate navigation is essential if the ship is to avoid dangerous rocks, and the navigator must know exactly where his ship is on a chart of the area. When he is out of sight of land, he depends on celestial or radio navigation methods. Aircraft depend mostly on radio navigation, because they move so fast the navigator or pilot needs results quickly. On landing, radar is used to make a continual check on the aircraft's position. Ships use radar to find their way in fog.

Nazism is the name by which Adolf Hitler's National Socialist ideas came to be known. Hitler helped build up the Nazi party after Germany's defeat in the First World War. His ideas were very extreme, and his followers were trained like soldiers.

Hitler came to power legally after the slump of 1929-32. During this crisis, six million Germans were unemployed, and many people voted for the Nazis hoping they could solve Germany's problems. Once in power, Hitler set up concentration camps for his opponents, abolished other political parties, and controlled all newspapers, radio and films. He insisted that as 'Aryans', Germans were a master race, destined to rule the world. Jews and Gypsies were systematically persecuted and murdered because they were considered members of inferior races. Unemployment was solved by expanding the armed forces and the armament industries. Then Hitler began seizing other countries, starting with Austria and part of Czechoslovakia in 1938. During the Second World War, Hitler's armies occupied most of Europe. He committed suicide in Berlin in 1945 when Germany was defeated.

This map shows the location of Nebraska.



Nebraska is an agricultural state in the midwestern United States. It is part of the fertile Great Plains region. Herds of cattle graze on Nebraska's grasslands, and pigs are also raised. Acres of wheat and other cereals grow on the extensively irrigated land. Slightly more than half of Nebraska's 1,484,000 people live in cities, such as Omaha, the largest, and Lincoln, the capital. The state's industries include production of farm machines and chemicals as well as meat-packing and food-processing. The United States bought the region that is now Nebraska from France in 1803, and made it a state in 1867.

Nebula is a name originally given to all kinds of misty objects in the sky whose real nature could not be discovered with the telescopes of the early astronomers. Some are distant galaxies. Others are star clusters and clouds of dust and gas within our own galaxy.

Some of the clusters are spherical in form, like a giant ball of stars, densely

Stars are still probably being 'born' in the dense clouds of gas and dust obscuring part of the Orion nebula. The new star cannot be seen until it radiates enough heat and light to penetrate the dark clouds.

packed in the centre but spaced farther apart at the outside. They are beautiful objects when seen in a telescope. They have been found inside other galaxies as well as our own.

The gaseous nebulae occur in two main forms—bright and dark. The bright ones are clouds of hot gas, mostly hydrogen. The best known example is in the constellation Orion, surrounding the middle star of the three said to represent Orion's sword. It can just be seen with the unaided eye on a clear night as a faint misty patch.

The dark nebulae are clouds of cool dust and gas which obscure the light from the stars beyond.

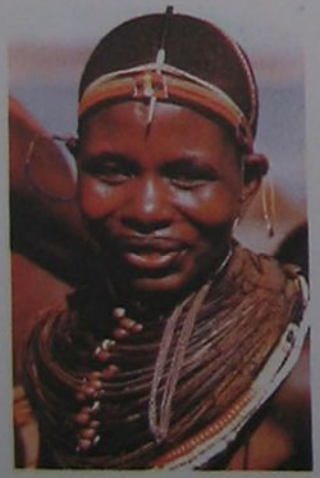
Negro is a word meaning black and is used to refer to peoples who originally came from Africa, south of the Sahara. They have dark skins, short woolly hair, thick lips, and broad flat noses. The Ashanti of Ghana and the Yoruba and Ibo tribes of Nigeria in western Africa are regarded as most typical. They are slenderly built, tall, and broad shouldered. It is from these people that most American Negroes are descended. Other groups include the Nilotic Negroes, such as the Dinka, who are generally tall, slim and blue-black in colour; the tall Nilo-Hamitic people such as the Masai; the Bantu-speaking peoples who live in southern Africa; and the Negrilloes, the pygmy people of the Congo basin.

The interior of Africa was unknown to

The Negro race is the most recently evolved of the three major human races (Caucasoid, Mongoloid and Negroid). There are no known remains of early Man with Negroid characteristics that are over 10,000 years old. The average height of the Negroid race is generally taller than that of the other races.

Europeans until the 19th century, and the various tribes lived without interference. They were organized in clans. Most were farmers, growing maize, cassava, and plantains—a fruit like a banana. In western Africa, yams (a root like the potato) were, and still are, the basic food. When the European powers moved into Africa there were many changes in the traditional tribal pattern. Wars and raiding expeditions were stopped. Africans began to work on European-owned farms, mines, and, eventually, factories. Traditional dress gave place to European-style clothes, and many Negroes became educated. There are still many problems concerning their status—and some newly formed independent African states are having difficulty establishing themselves.

Negroes living in the United States are native-born Americans, descended from slaves brought to America between 1619 and 1808, after which slave-trading was forbidden. With the ratification of the Emancipation Bill in 1865, all Negroes were freed from slavery. Many still work in the Southern States, cultivating cotton and tobacco. They have kept much of their own distinctive culture, and have greatly influenced jazz music.



Left: This young African girl has typically Negroid features.

Right: Descendants of Negro slaves form a significant proportion of the population of the United States. Here a kindergarten class sings Christmas carols at an elementary school in Washington D.C.